



ENERGY STAR® Program Requirements for Luminaires

Eligibility Criteria – Version 1.0, DRAFT 2

Note: This specification replaces the ENERGY STAR Residential Light Fixtures and Solid State Lighting Luminaires specifications.

Primary Contact Information

Note: For purposes of this specification development process, EPA invites stakeholders to send comments to luminaires@energystar.gov, with “ENERGY STAR Luminaires Second Draft Comments” in the subject line.

Your Primary Contact Information

To effectively communicate important news to our partners, the ENERGY STAR program needs your help keeping your company's contact information up to date. It is one of your partner commitments and it's easy to do: please visit www.energystar.gov/partners to log in.

Specification Scope & Luminaire Classification

The ENERGY STAR Luminaires specification (“this specification”) covers the luminaire types outlined in this section. Qualification is limited to luminaires below a total input power of 250 watts.

The next section of this specification (“How to Use This Document”) details the differences in testing and performance requirements for directional and non-directional luminaires. Refer to the Definitions section for definitions of each luminaire type detailed below.

DIRECTIONAL FOR PURPOSES OF THIS SPECIFICATION:

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| <ul style="list-style-type: none">○ Residential grade luminaires, specifically:<ul style="list-style-type: none">▪ accent lights (formerly “surface mount with directional head(s)”) <ul style="list-style-type: none">○ includes line-voltage directional track lights○ includes directional ceiling fan light kits▪ cove mounts▪ downlights: recessed, pendant, surface mount <ul style="list-style-type: none">○ includes SSL retrofits▪ outdoor post-mounted luminaires▪ under cabinet luminaires▪ all inseparable SSL luminaires | <ul style="list-style-type: none">○ Commercial grade luminaires, specifically:<ul style="list-style-type: none">▪ downlights: recessed, pendant, surface mount <ul style="list-style-type: none">○ includes SSL retrofits○ excludes troffers or linear forms▪ under cabinet shelf-mounted task lighting▪ portable desk task lights |
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Note: Luminaires not classified above as directional default to non-directional classification for purposes of meeting performance requirements outlined in this specification.

NON-DIRECTIONAL FOR PURPOSES OF THIS SPECIFICATION:

Residential grade luminaires only, **including by not limited to:**

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|--|---|
| <ul style="list-style-type: none">○ Indoor:<ul style="list-style-type: none">▪ bath vanity▪ ceiling and close-to-ceiling mount <ul style="list-style-type: none">○ includes non-directional ceiling fan light kits○ includes ventilation fan light kits▪ chandeliers▪ decorative pendants▪ linear strips▪ “table lamps” and “floor lamps”▪ torchieres▪ wall sconces▪ wrapped lens | <ul style="list-style-type: none">○ Outdoor:<ul style="list-style-type: none">▪ ceiling and close-to-ceiling mount▪ porch▪ pendant▪ security |
|--|---|

Note: Some luminaire type names above have been changed from draft 1. Please see the Definitions section of this document for detailed definitions of each of the luminaire types listed above. Accent lights (formerly “surface mount with directional head(s)”) now also encompass line-voltage directional track heads. The downlight definition has been expanded to clarify which luminaire shapes are eligible to be labeled, and to add SSL retrofit products, which UL evaluates as luminaires despite the ANSI lamp base. In this draft, outdoor ‘arm-mounted’ luminaires have been removed to minimize confusion between residential outdoor luminaires and area and roadway luminaires. The above now indicates only “outdoor post-mounted luminaires”.

Development of an ENERGY STAR specification for outdoor pole-mounted area and roadway luminaires, wall packs and parking garage/canopy luminaires is currently on hold as DOE & EPA await industry development of a technology-neutral test procedure which will allow for evaluations of high performance luminaires. NEMA is leading this development effort. Once developed, the specification will be a separate document from this Luminaires specification.

Regarding expansion of this specification to cover additional indoor commercial luminaire types:

Since the ENERGY STAR Program was expanded in 1995 to include commercial buildings, EPA has been committed to promoting a systems approach to recognizing high performing buildings with the label. By focusing primarily on plug-load commercial products, the product labeling program has been careful not to undermine what has been demonstrated to be a more effective approach to improving building efficiency. Consistent with this principle, EPA does not intend to expand the scope of the ENERGY STAR Luminaires specification for commercial applications beyond the luminaire types already included.

How to Use This Document

To qualify a luminaire for ENERGY STAR, first determine which requirements in this document are applicable to the specific luminaire. ENERGY STAR requirements are specific to directional and non-directional applications:

- Directional luminaires:
 - defined in the above Specification Scope & Luminaire Classification section
 - evaluated with luminaire photometry, accounting for luminaire optical performance
 - shall also meet specified minimum light output and zonal lumen density requirements
 - residential grade luminaires featuring inseparable solid state (LED) componentry shall be considered directional for purposes of this specification and therefore evaluated with luminaire photometry
 - all other luminaire types default to non-directional, below
- Non-directional luminaires:
 - defined in the above Specification Scope & Luminaire Classification section
 - evaluated by source photometry
 - luminaires not defined as directional are evaluated as non-directional

Please note that this specification is not organized by indoor or outdoor, or by light source technology. Performance requirements comprise each section of this document, thus the first section summarizes efficacy requirements, the second color performance, etc. Partners are advised to review each section, and take note of exceptions where specific performance criteria need not be evaluated; for instance, some exceptions are in place for outdoor luminaires.

Luminaire manufacturers may elect to use ENERGY STAR qualified GU24 based lamps featuring integral ballasts or drivers to meet performance requirements in this specification. See energystar.gov for a qualifying product list.

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Definitions

Accent Light (Luminaire): A directional luminaire employed to emphasize a particular object or surface feature, or to draw attention to a part of the field of view (adapted from IES RP-16-10: "Accent Lighting"). Includes line-voltage directional track luminaires.

ALA: American Lighting Association.

ANSI: American National Standards Institute.

Aperture Size (downlights): The maximum distance between the points inside the luminaire where light escapes the luminaire.

ASSIST: Alliance for Solid State Illumination Systems and Technologies.

ASTM: American Society for Testing of Materials.

Ballast: A device used with an electric-discharge lamp to obtain the necessary circuit conditions (voltage, current, and waveform) for starting and operating. (IES RP-16-10)

Ballast Frequency: The number of waves or cycles of electromagnetic radiation per second, usually measured in Hz. (Lighting Fundamentals Handbook, Electric Power Research Institute, 1992)

Bath Vanity Luminaire: Wall-mounted luminaires located adjacent to a mirror.

Ceiling / Close-to-Ceiling Mount Luminaire: Ceiling-mounted luminaires that direct less than 90% of light downward and are not intended to accent an object or an area within a space.

CFL: A compact fluorescent lamp (pin based or self-ballasted screw base). See Compact Fluorescent Lamp.

Chandeliers: Decorative, often branched, luminaires suspended from the ceiling incorporating multiple light sources.

CIE: Commission Internationale de l'Eclairage (International Commission on Illumination).

Color Rendering: A general expression for the effect of a light source on the color appearance of objects in conscious or subconscious comparison with their color appearance under a reference light source. (IES Handbook 9th Edition)

Color Rendering Index (CRI): A measure of the degree of color shift objects undergo when illuminated by the light source as compared with those same objects when illuminated by a reference source of comparable color temperature. (IES Handbook 9th Edition)

Compact Fluorescent Lamp (CFL): A fluorescent lamp with a small diameter glass tube (T5 or less) that is folded, bent, or bridged to create a long discharge path in a small volume. The lamp design generally includes an amalgam and a cold chamber, or a cold spot to control the mercury vapor pressure and light output. (IES RP-16-10)

Commercial Luminaire: A luminaire marketed and intended to be used in a commercial, industrial or business environment, exclusive of a device which is marketed for use by the general public or is intended to be used in the home. (adapted from FCC 47 CFR parts 15 and 18)

Correlated Color Temperature (CCT): The absolute temperature of a blackbody whose chromaticity most nearly resembles that of the light source. (IES Handbook 9th Edition).

Cove Lighting: Lighting comprising light sources shielded by a ledge or horizontal recess, and distributing light over the ceiling and upper wall (IES RP-16-10)

Covered Lamp: A lamp with an integral ballast and a translucent cover over the bare fluorescent glass tube.

CSA: Canadian Standards Association.

Decorative Pendant (luminaire): Suspended luminaires that are not intended to accent an object or an area within a space, and typically employ blown glass, or colorful glass elements.

Direct Lighting: Lighting involving luminaires that distribute 90 to 100 percent of the emitted light in the general direction of the surface to be illuminated. This term usually refers to light emitted in a downward direction. (IES RP-16-10)

Directional Applications: See Direct Lighting.

Directional Luminaires: See Direct Lighting.

Down Light or Downlight (luminaire): A small direct lighting unit that directs the light downward and can be recessed, surface mounted, or suspended (IES RP-16-10). See definition of Direct Lighting for additional information. For purposes of this specification, this definition includes down light luminaire SSL retrofits but does not include troffers or linear forms such as linear fluorescent pendants, typically used to illuminate office spaces.

Electronic Ballast: A device which operates at a supply frequency of 50 or 60 Hz and operates the lamp at frequencies greater than 10 kHz. (ANSI standard C82.13-2002)

Floor Lamp (Luminaire): a portable luminaire on a high stand suitable for standing on the floor. (IES RP-16-10)

GU24 Based Integrated Lamp: A lamp unit that integrates the lamp and its ballast. It does not include any replaceable or interchangeable parts, and utilizes the ANSI standardized GU24 base type.

GU24 Based Two-Piece Lamp: A term for a lamp-ballast unit that includes a ballast with the ANSI standardized GU24 base type paired with a standard pin based lamp. The ballast and lamp are separable, with the ballast designed to accept replacement pin based lamps.

High Frequency (Electronic) Ballast: see Electronic Ballast.

IEC: International Electrotechnical Commission.

IES: Illuminating Engineering Society.

Initial Performance Values: The photometric and electrical characteristics at the end of the 100-hour aging period in a 25°C test environment.

Input Power: The power consumption in watts of a ballast or driver and a light source system operating in a normal mode, as determined in accordance with the test procedure (ANSI Standard 82.2-2002)

Inseparable SSL Luminaire: A luminaire featuring solid state lighting components (i.e. LEDs and driver components) which cannot be easily removed or replaced by the end user, thus requiring replacement of the entire luminaire. Removal of solid state lighting components would require (for instance) the cutting of wires, use of a soldering iron, or damage to or destruction of the luminaire. Luminaires which feature LED light engines which are user replaceable / upgradeable without the cutting of wires or the use of solder are not considered inseparable.

Lamp-Ballast Platform: A pairing of one ballast with one or more lamps that can operate simultaneously on that ballast. A unique platform is defined by the manufacturer and model number of the ballast and lamp(s) and the quantity of lamps that operate on the ballast. A lamp-ballast platform also may refer to a lamp with an integral ballast, such as a GU24 based integrated lamp.

Lamp Current Crest Factor: For 60Hz operation, the ratio of peak lamp current to the root mean square (RMS) lamp current. For high-frequency (HF) operation, the highest peak lamp current of the modulation envelope (when evaluated over a full line voltage cycle) to the root mean square (RMS) of the lamp current.

Lamp: A generic term for a man-made source create to produce optical radiation. By extension, the term is also used to denote sources that radiate in regions of the spectrum adjacent to the visible.” (IES Handbook 9th Edition)

Lampholder: A component of a luminaire, which supplies power to the lamp and also holds the lamp in place.

LED: See Light Emitting Diode.

LED Array or Module: An assembly of LED packages (components) or dies on a printed circuit board or substrate, possibly with optical elements and additional thermal, mechanical, and electrical interfaces that are intended to connect to the load side of a LED driver. Power source and ANSI standard base are not incorporated into the device. The device cannot be connected directly to the branch circuit. (IES RP-16-10)

LED Control Circuitry: Electronic components designed to control a power source by adjusting output voltage, current or duty cycle to switch or otherwise control the amount and characteristics of the electrical energy delivered to a LED package (component) or an LED array (module). LED control circuitry does include power source. (IES RP-16-10)

LED Driver: A device comprised of a power source and LED control circuitry designed to operate a LED package (component), or an LED array (module) or an LED lamp. (IES RP-16-10)

LED Driver Case Temperature Measurement Point (TMP_C): A location on an LED driver case, designated by its manufacturer, which will have the highest temperature of any point on the driver case during normal operation.

LED Driver Class II: An LED driver that operates within Class II limits as defined by the latest version of the National Electrical Code (NEC) and the Canadian Electrical Code (CEC). (IES RP-16-10)

LED Light Engine: An integrated assembly comprised of LED packages (components) or LED arrays (modules), LED driver, and other optical, thermal, mechanical and electrical components. The device is intended to connect directly to the branch circuit through a custom connector compatible with the LED luminaire for which it was designed and does not use an ANSI standard base. (IES RP-16-10)

LED Luminaire: A complete lighting unit consisting of LED-based light emitting elements and a matched driver together with parts to distribute light, to position and protect the light emitting elements, and to connect the unit to a branch circuit. The LED-based light emitting elements may take the form of LED packages (components), LED arrays (modules), LED Light Engine, or LED lamps. The LED luminaire is intended to connect directly to a branch circuit. (IES RP-16-10)

LED Module: See LED Array or Module.

LED Package: An assembly of one or more LED dies that includes wire bond or other type of electrical connections,, possibly with an optical element and thermal, mechanical, and electrical interfaces. Power source and ANSI standardized base are not incorporated into the device. The device cannot be connected directly to the branch circuit. (IES RP-16-10)

LED Platform: See LED Light Engine.

LED Temperature Measurement Point (TMP_{LED}): A location on an LED package/module/array, designated by its manufacturer, which provides a surrogate temperature measurement location for the actual LED junction. The TMP_{LED} may be a solder joint at the board attachment site, a point on the LED package case, or a location on the board of an LED module or array.

Light Emitting Diode (LED): A pn junction semiconductor device that emits incoherent optical radiation when forward biased. The optical emission may be in the ultraviolet, visible, or infrared wavelength regions. (IES RP-16-10)

Linear Strip Luminaire: Surface mounted luminaires with an elongated aspect ratio and either no optics over the light source(s) or individual optics over each light source.

Luminaire (Light Fixture): A complete lighting unit consisting of lamp(s) and ballast(s) (when applicable) together with the parts designed to distribute the light, position and protect the lamps, and to connect the lamp(s) to the power supply (IES RP-16-10)

Linear Fluorescent Lamp: Commonly made with straight, tubular bulbs varying from approximately .25” to 2.125” and in overall length from 4” to 96”. The Fluorescent Lamp is a low-pressure mercury electric-discharge lamp in which a fluorescing coating (phosphor) transforms some of the UV energy generated by the discharge into light. (IES Handbook 9th Edition)

Lumen Maintenance: The luminous flux output remaining (typically expressed as a percentage of the initial output) at any selected elapsed operating time. Lumen maintenance is the converse of lumen depreciation. (adapted from IES LM-80-08)

Lumens per Watt (lm/W): The quotient of the total luminous flux emitted by the total lamp power input. It is expressed in lm/W. (adapted from IES RP-16-10: “Luminous Efficacy of a Source of Light”)

Luminaire Efficacy: The luminous flux delivered by a luminaire, divided by its input power.

MacAdam Color Ellipse: A series of ellipses around the chromaticity coordinates of a number of different colors. Each ellipse sets the boundary at which a given percentage of people are able to determine that two colors, one with the chromaticity coordinates at the center of the ellipse, and one with chromaticity coordinates on the ellipse, are just noticeably different. (IES Handbook 9th Edition)

Magnetic Ballast: A magnetic device used to control the starting and operation of discharge lamps. (IES Handbook 9th Edition)

Nadir: The angle pointing directly downward from the luminaire, or zero degrees.

NEMA: National Electrical Manufacturers Association.

NFPA: The National Fire Protection Association (United States), which develops the National Electrical Code (NEC).

Non-Directional Application: For purposes of this ENERGY STAR specification, luminaire application types which are not designated directional. See Direct Lighting definition.

Non-Directional Luminaire: See Non-Directional Application.

NRTL: Nationally Recognized Testing Laboratory as recognized by OSHA’s NRTL Program, which is a part of OSHA’s Directorate of Technical Support.

Optics: Include reflectors, baffles, lenses and/or diffusers, all of which control the light distribution and the appearance of the lighted luminaire.

OSHA: Occupational Safety & Health Administration.

Outdoor Pendant Luminaire: An outdoor suspended luminaire.

Outdoor Porch Luminaire: An outdoor ceiling, surface or wall-mounted luminaire.

Outdoor Post-Mounted Luminaire: An outdoor luminaire supported by a post inserted into the ground and mounted between 4 feet and 10.5 feet above grade.

Outdoor Security Luminaire: Wall mounted luminaires intended to light areas immediately adjacent to a building's perimeter.

Photo Control or Light Activated Switch: A photoelectric switch that controls lighting by the level of daylight luminance (IES RP-16-10)

Photosensor: See Photo Control.

Platform: See Lamp-Ballast Platform.

Portable Desk Task Light (Luminaire): A desk light that directs light to a specific surface or area to provide light for visual tasks such as reading and writing, and employs a NEMA 1-15P or 5-15P plug for its electrical connection.

Portable Luminaire: A lighting unit that is not permanently fixed in place. (IES RP-16-10)

Power Factor: The power input in watts divided by the product of ballast input voltage and input current of a fluorescent lamp ballast, as measured under test conditions (ANSI Standard C82.2–2002).

Power Source: A transformer, power supply, battery, or other device capable of providing current, voltage, or power within its design limits. This device contains no additional control capabilities (IES RP-16-10)

Rated Lumen Maintenance Life (L_p): The elapsed operating time over which the LED light source will maintain the percentage, p , of its initial light output, e.g. L_{70} (hours): Time to 70% lumen maintenance. (IES LM-80-08)

Residential Luminaire: A luminaire marketed and intended to be used in a residential environment notwithstanding use in commercial, business and industrial environments. (adapted from FCC 47 CFR parts 15 and 18)

RLF: Residential light fixture.

Run-up Time: The time needed after switching on the supply for the lamp to reach 80.0% of its stabilized luminous flux. (ANSI C78.5-2003)

Solid State Lighting (SSL): The term “solid state” refers to the fact that the light is emitted from a solid object – a block of semiconductor – rather than from a vacuum or gas tube, as in the case of a incandescent and fluorescent lighting. There are two types of solid-state light emitters: inorganic light-emitting diodes (LEDs) or organic light-emitting diodes (OLEDs). (Sandia National Laboratories)

Standardized Color Ellipse: A MacAdam color ellipse defined by center chromaticity coordinates (CIE x , y) and a measure of certainty for detecting a color difference specified in standard deviation units called steps. (ANSI C78.376-2001)

Table Lamp (Luminaire): A portable luminaire with a short stand suitable for standing on furniture. (IES RP-16-10)

Torchiere (Luminaire): An indirect floor lamp that sends all or nearly all of its light upward. (IES RP-16-10)

Trim: Trim is the part of a downlight that covers the ragged edge of the ceiling cut-out. The trim may be a separate ring, or trim ring, or it may be integrated with the optics (i.e., a self-flanged reflector). Airtight or non-airtight.

UL: Underwriters Laboratories.

Under-Cabinet Luminaire: Luminaires installed below an upper cabinet to direct light down to the work surface of a countertop or desk for task lighting.

Wall Sconce (Luminaire): Wall mounted luminaires not intended to accent an object or a task area within a space.

Wrapped Lens Luminaire: Surface mounted luminaires with an elongated aspect ratio and a single optic covering the light source that direct less than 90% of light downward.

Note: Along with the addition of definitions for each luminaire type detailed on the front page, several of the above definitions have been revised since draft 1.

References have been updated, including references to the recently published IES RP-16-10.

The Manufacturer Designated Temperature Measurement Point (T_{MP}) definition has been removed as the concept is more specifically covered by definitions for LED Temperature Measurement Point ($T_{MP,LED}$) and LED Driver Case Temperature Measurement Point ($T_{MP,C}$).

The definition of ‘inseparable SSL luminaire’ has been expanded to further clarify the concept, and to explain that luminaires featuring upgradable or replaceable internal components (e.g. complete LED light engines) are not included in this definition.

Test Criteria

When testing luminaires, the test methods identified for each performance characteristic in the "Methods of Measurement and/or Reference Standards" column of the performance requirements tables presented within this specification shall be used to determine ENERGY STAR qualification.

Product Qualification

A. Product Families: grouped product submissions for ENERGY STAR qualification shall meet the following requirements:

Qualified products within a product family shall be identical to the tested, representative model with the exception of allowed variations listed in Table 1, below. The representative model shall be the variation expected to have the greatest difficulty meeting the performance criteria outlined in this specification.

Table 1: Allowable Variations Within Product Families	
Housing / Chassis	Allowed so long as the light source or lampholder, ballast or driver, and heat sink (as applicable) are integrated into housing / chassis variations in such a way that the thermal performance of the luminaire is not degraded by changes to the housing / chassis. Thermal measurements of each variation may be required (e.g. ballast case temperature, TMP _{LED} , or TMP _C).
Heat Sink / Thermal Management Components	Not allowed.
Finish	Allowed.
Mounting	
Reflector / Trim	Allowed so long as luminaire light output is not reduced.
Shade / Diffuser	Allowed so long as neither luminaire light output nor air flow are reduced.
Light Source (refers to the make and/or model of the source; also review CCT below)	Allowed so long as variations will not negatively impact luminaire's compliance with any performance criteria in this specification.
Correlated Color Temperature (CCT) (also review Light Source above)	Allowed so long as the lamp series or LED package/module/array series (and associated drive current), ballast or driver, and thermal management components are identical, and so long as variations will not negatively impact luminaire's compliance with any performance criteria in this specification. The representative model shall be the version within the product family with the lowest CCT. Partner shall use different luminaire model numbers to distinguish between models with different CCTs.
Ballast / Driver	Allowed so long as variations will not negatively impact luminaire's compliance with any performance criteria in this specification. Thermal measurements of each variation may be required (e.g. ballast case temperature, or TMP _C).

Partners may not retroactively add variations to a product family unless requirements in Table 1 are still met. For example, if the representative model tested is 3000 Kelvin, partner may not retroactively add a 2700 Kelvin, as this was not the lowest CCT tested initially.

B. Significant Digits and Rounding

- All calculations shall be carried out with actual measured or observed values. Only the final result of a calculation shall be rounded. Calculated results shall be rounded to the nearest significant digit as expressed in the corresponding specification limit.
- Unless otherwise specified, compliance with specification limit shall be evaluated using exact values without any benefit from rounding.

Note: Since the release of draft 1, the Agency has developed enhanced testing and verification requirements for all product categories labeled by the ENERGY STAR program. Included in these enhancements is the requirement – as of January 1, 2011 – that all labeled products must be tested at an EPA-recognized laboratory, and that the resulting test data must be *certified* by an EPA-recognized certification body. More information is available at www.energystar.gov/testingandverification

In the next draft of this specification, EPA will release details of a next-generation system for third-party *certification* of luminaire subcomponents, including lamps, ballasts, and lamp-ballast platforms. Please note that these components themselves will not be eligible for ENERGY STAR *qualification*, only *certification* in support of ENERGY STAR *qualification* of complete luminaires. This system is intended to replace and combine both the [NEMA/ALA Lamp and Ballast Matrices](#) and the existing EPA-managed [Platform Database](#), while providing similar functionality and ease of use for luminaire manufacturers. The system will fully conform to the ENERGY STAR labeling program's enhanced testing requirements, requiring testing and certification of subcomponents by EPA-recognized laboratories and certification bodies.

Above references to “product groupings” have been changed to “product families” to align with convention across all ENERGY STAR labeled products. Table 1 above has been extensively modified since draft 1; partners are encouraged to carefully review this table and provide comment. Note that the product family section is no longer divided into separate subsections for directional and non-directional luminaires.

Language in above section B “Significant Digits and Rounding” is now conventional, found in all specifications for the ENERGY STAR labeled products program.

The “Technical Notes” section from draft 1 has been removed; applicable notes have been woven into the rest of the specification.

Effective Date

The ENERGY STAR Luminaires specification shall take effect on September 1, 2011. To qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on its date of manufacture. The date of manufacture is specific to each unit and is the exact date on which a unit is considered to be completely assembled.

Future Specification Revisions

EPA reserves the right to change this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through industry discussions. In the event of a specification revision, please note that ENERGY STAR qualification is not automatically granted for the life of a product model.

While this document currently refers to industry standards and test procedures for fluorescent, high intensity discharge and solid state sources, as new technologies emerge that have equal or better performance to the levels proposed here, consistent with a technology neutral approach, EPA may amend the program requirements by adding additional requirements, standards, and test procedures.

Measurement Tolerances

Note: EPA is currently reviewing the tolerances detailed in the enclosed methods of measurement to determine if they are sufficient for purposes of ensuring performance and quality, and also to determine where tolerance values, if needed, are not sufficiently addressed. Tolerance information will be supplied to EPA-recognized certification bodies.

Reference Standards and Test Procedures

Organization	Identifier	Description
ANSI	C78.376-2001	Specifications for the Chromaticity of Fluorescent Lamps
ANSI	C78.377-2008	Specifications for the Chromaticity of Solid State Lighting Products
ANSI	C78.389-2004 (R2008)	American National Standard for Electric Lamps—High-Intensity Discharge (HID)—Methods of Measuring Characteristics
ANSI	C78.43-2007	American National Standard for Electric Lamps—Single-Ended Metal Halide Lamps
ANSI	C78.5-2003	Specifications for Performance of Self-ballasted Compact Fluorescent Lamps
ANSI	C78.81-2010	Double-Capped Fluorescent Lamps—Dimensional and Electrical Characteristics
ANSI	C82.14-2006	American National Standard for Lamp Ballasts—Low-Frequency Square Wave Electronic Ballasts—for Metal Halide Lamps
ANSI	C78.901-2005	Single-Based Fluorescent Lamps—Dimensional and Electrical Characteristics
ANSI	C81.61-2009	Specifications for Bases (Caps) for Electric Lamps
ANSI	C81.62-2009	Lampholders for Electric Lamps
ANSI	C82.1-2004	Electric Lamp Ballast - Line Frequency Fluorescent Lamp Ballast
ANSI	C82.11 Consolidated-2002	High-Frequency Fluorescent Lamp Ballasts—Supplements
ANSI	C82.2-2002	Method of Measurement of Fluorescent Lamp Ballasts
ANSI	C82.4-2002	For Lamp Ballasts- Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple Supply Types)
ANSI	C82.6-2005	Ballast For High Intensity Discharge Lamps - Methods Of Measurement
ANSI	C82.77-2002	Harmonic Emission Limits—Related Power Quality Requirements for Lighting Equipment
ANSI/IEEE	C62.41-1991	Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
ASSIST	Recommends Vol. 4 Issue 1	ASSIST Recommends: Recommendations for Testing and Evaluating White LED Light Engines and Integrated LED Lamps Used in Decorative Lighting Luminaires. Vol 4, Issue 1, May 2008.
ASTM	E283-04	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
CIE	Pub. No. 13.3-1995	Method of Measuring and Specifying Color Rendering of Light Sources
CIE	Pub. No. 15:2004	Colorimetry
EU	Directive 2002/95/EC	Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the Restriction of the use of Certain Hazardous Substances in Electrical and Electronic Equipment
FCC	CFR Title 47 Part 15	Radio Frequency Devices
FCC	CFR Title 47 Part 18	Industrial, Scientific, and Medical Equipment
FTC	CFR Title 16	Commercial Practices
IEC	60061-1	Lamp Caps and Holders Together with Gauges for the Control of Interchangeability and Safety – Part 1: Lamp Caps
IEC	60081 Amend 4 Ed 5.0	Double-capped Fluorescent Lamps - Performance Specifications
IEC	60901	Single-capped Fluorescent Lamps - Performance Specifications
IEC	61347-2-3-am2 ed1.0	Amendment 2 - Lamp Control Gear - Part 2-3: Particular Requirements for A.C. Supplied Electronic Ballasts for Fluorescent Lamps
IES	LM-9-09	Electric and Photometric Measurements of Fluorescent Lamps
IES	LM-10-96	Photometric Testing of Outdoor Fluorescent Luminaires
IES	LM-16-93	Correlated Color Temperature
IES	LM-31-95	Photometric Testing of Roadway Luminaires Using Incandescent Filament and HID Lamps
IES	LM-40-01	Approved Method for Life Performance Testing of Fluorescent Lamps
IES	LM 41-98	IES Approved Method for Photometric Testing of Indoor Fluorescent Luminaires
IES	LM-46-04	Photometric Testing of Indoor Luminaires Using High Intensity Discharge or Incandescent Filament Lamps
IES	LM 47-01	Life Testing of High Intensity Discharge (HID) Lamps
IES	LM-49-01	Life Testing of General Lighting Incandescent Filament Lamps
IES	LM-51-00	Electrical and Photometric Measurements of HID Lamps
IES	LM-58-94	Guide to Spectroradiometric Measurements
IES	LM-65-01	Life Testing of Single-Ended Compact Fluorescent Lamps
IES	LM-66-00	Electrical and Photometric Measurements of Single-Ended Compact Fluorescent Lamps.
IES	LM-79-08	Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
IES	LM-80-08	Approved Method: Measuring Lumen Maintenance of LED Light Sources
IES	RP 16-10	Nomenclature and Definitions for Illuminating Engineering
IES	TM-21-11	Projecting Long Term Lumen Maintenance of LED Packages (in draft 5/2010)
LRC	ACTV Test 2007	Accelerated Cycling Thermal Voltage Stress Test
NEMA	LL 9-2010	Dimming of T8 Fluorescent Lighting Systems
NFPA	NFPA 70 (2008)	National Electric Code
UL	UL 153-2002	Portable Electric Luminaires
UL	ANSI/UL 935-2001	Fluorescent-Lamp Ballasts
UL	ANSI/UL 1029-2009	High-Intensity-Discharge Lamp Ballasts
UL	UL 1012-2005	Power Units Other Than Class 2
UL	UL 1310-2005	Class 2 Power Units
UL	ANSI/UL 1598-2008	Luminaires
UL	ANSI/UL 1993-2009	Self-Ballasted Lamps and Lamp Adapters
UL	ANSI/UL 1994-2004	Luminous Egress Path Marking Systems
UL	ANSI/UL 8750-2009	Light Emitting Diode (LED) Light Sources for Use in Lighting Products

Photometric Performance Requirements

Luminous Efficacy and Output Requirements: NON-DIRECTIONAL RESIDENTIAL Luminaires

Note: Luminaire types not denoted as directional on the first page of this specification shall be evaluated as non-directional, based on source photometry. The performance values in this section pertain to the performance of the source (system including ballast or driver) within a luminaire.

Source Type	ENERGY STAR Requirements		Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
	Source Efficacy	Source Minimum Light Output		
Fluorescent <ul style="list-style-type: none"> linear compact self ballasted compact (GU24) circline 	<p>Until Sept. 1, 2013: ≥ 65 lm/W per lamp-ballast platform</p> <p>After Sept. 1, 2013: ≥ 70 lm/W per lamp-ballast platform</p> <p>All lamp and ballast permutations (makes and models) employed in a given luminaire model shall meet this requirement.</p>	<p>Lamp-ballast platform shall provide a minimum of 800 lumens.</p> <p><u>Exception:</u> chandeliers and bath vanity luminaires featuring more than 3 heads shall provide a minimum of 450 lumens per head.</p>	<p>Linear & circline: IES LM-9-09</p> <p>Compact & self ballasted compact: IES LM-66-00</p> <p>ANSI C78.81-2010 (for T8)</p> <p>IEC 60081 data sheets (for T5)</p>	<p>Laboratory test results shall be produced using the specific lamp and ballast combination that will be used in production.</p> <p>Linear fluorescent luminaires which do not ship with lamps shall be tested using lamps compliant with ANSI C78.81-2010 (for T8) or IEC 60081 data sheets (for T5).</p> <p>Luminaires with ballast(s) capable of operating multiple fluorescent lamp types shall be tested either with the lamp(s) shipped with the luminaire, or if a lamp is not supplied, with one of the lamp types detailed on the packaging.</p> <p>Sample Size: ≥ 3 lamp-ballast combination samples shall be tested.</p> <p>Passing Test: all samples shall pass.</p>
High Intensity Discharge <ul style="list-style-type: none"> metal halide ceramic metal halide high pressure sodium 	<p><u>Exception:</u> Covered and dimmable versions of GU24 based integrated lamps are required to meet reduced efficacy requirements as outlined in qualification requirements for those lamps.</p>		<p>IES LM-51-00</p>	<p>Laboratory test results shall be produced using the specific lamp and ballast combination that will be used in production.</p> <p>Luminaires with ballast(s) capable of operating multiple lamp types shall be tested with the lamp(s) shipped with the luminaire.</p> <p>Sample Size: ≥ 3 lamp-ballast combination samples shall be tested.</p> <p>Passing Test: all samples shall pass.</p>
Solid State: LED Light Engine	<p>LED light engine efficacy shall meet or exceed the values detailed below, as determined by comparing the <i>in situ</i> T_b temperature and the LED light engine LM-xx test report.</p> <p>Until Sept. 1, 2013: ≥ 65 lm/W per LED light engine</p> <p>After Sept. 1, 2013: ≥ 70 lm/W per LED light engine</p>	<p>Each LED light engine <i>in situ</i> shall provide a minimum of 800 lumens.</p> <p><u>Exception:</u> chandeliers and bath vanity luminaires featuring more than 3 heads shall provide a minimum of 450 lumens per head.</p>	<p>IES LM-xx-1x</p> <p>Note: EPA is working with industry to develop the above test procedure:</p> <p><i>IES Approved Method for the Characterization of LED Light Engines and Integrated LED Lamps for Electrical and Photometric Properties as a Function of Temperature</i></p>	<p>Laboratory test results shall be produced using the specific LED package(s), LED module(s) or LED array(s) and LED driver combination (LED light engine) that will be used in production.</p> <p>Sample Size:</p> <ul style="list-style-type: none"> 1 complete luminaire sample (LED light engine installed); and 2 additional LED light engine samples external to luminaire; and Any components and/or materials required to install additional LED light engines in luminaire. <p>Passing Test: all LED light engine samples, tested in the luminaire, shall pass.</p>

Halogen Incandescent (outdoor only)	<p>Qualification using halogen incandescent lamps is available for outdoor luminaires employing the following lampholders: E11, E26, G4, GX5.3, GY6.35.</p> <p>Improved product efficiency is achieved through minimized operating time. Qualifying luminaire shall operate with an integral in-line motion sensor device that meets the following criteria:</p> <ul style="list-style-type: none"> • ensures automatic shut-off of the lamp(s) within 15 minutes of being manually activated by a switch or automatically activated by the sensor, and • automatically resets to sensing mode within 6 hours of a manual override or testing operation, and • has an indicator that visibly or audibly informs the device operator that the motion sensor is operating properly, or that it has failed or malfunctioned, and • meets Off-State Power Consumption Requirements in this specification <p>With the exception of manual override or testing operation, luminaires may not continuously operate the lamps. Luminaires may not offer any form of permanent motion sensor defeat. Additionally, instructions provided with luminaire may not detail permanent methods of defeat.</p>	<p>Lampholder: ANSI C81.62-2009</p>	<p>None.</p>
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Note: Throughout the specification, the “Required Documentation” column has been replaced with “Supplemental Testing Guidance”. With the implementation of Enhanced Testing and Verification, EPA will assist certification bodies (CB) with identifying documentation appropriate to demonstrate compliance with the ENERGY STAR specifications. The CBs will in turn work with partners to gather necessary documentation.

Numerous partners have expressed concerns that a 70 lm/W source efficacy requirement would be too restrictive in the short term, but feel that longer term this is more realistic. With this in mind, the Agency has in this draft proposed a phased approach to increasing source efficacy requirements, beginning with 65 lm/W when the specification becomes effective, followed by an increase to 70 lm/W two years later. EPA believes this is consistent with our goal of designating top performers while ensuring adequate selection and cost effectiveness. With this proposal, to maintain qualification status of products initially qualified at 65 lm/W, partners would be required to demonstrate those products’ compliance with the higher performance level, once effective in 2013.

On June 8, 2010, EPA held a [webinar](#) during which the Agency presented an analysis of efficacy values found among currently qualified fluorescent luminaires. The above efficacy levels represent performance increases of 30 to 40% (65 to 70 lm/W) over the nominal 50 lm/W requirement in the current Residential Light Fixture v4.2 specification, and also represent what is both cost effective and broadly accessible.

Development of the above mentioned LED light engine test procedure – which itself references LM-79 for all photometric and electrical performance measurements – is moving forward and is expected to be complete for the effective date of this specification. Working group participants are currently conducting testing to validate the procedure.

Regarding minimum light output requirements, in response to stakeholder input that 850 lumens may be too high, the Agency has revised this value to 800 lumens, and adjusted the multi-head fixture allowance to ‘more than 3 heads’, expanding the same to include bath vanity luminaires. The 800 lumen value is roughly equivalent to the light output of a 60 watt A-19 incandescent lamp. The luminaire types denoted as non-directional generally employ omnidirectional sources such as a 60 watt A-19 lamp, to illuminate elements of the luminaire (e.g. decorative glass) while also distributing light into the space. EPA notes that generally, these are not the types of luminaires which would benefit from the directionality of LED packages; rather, luminaire manufacturers (and LED light engine developers) will employ various methods to distribute LED output in a variety of directions.

While some partners have expressed concern that a minimum light output requirement may limit the ability of partners to qualify luminaires with small lumen packages, the Agency notes that of the more than 28,000 models currently qualified under the current Residential Light Fixture specification (which also evaluates source efficacy), less than 6% of qualified models employ lamps with an output of less than 800 lumens, indicating historically low interest in qualification of such products.

Language regarding manual override capabilities has been reinserted into the above halogen incandescent requirements, with a required return to normal sensing operation within 6 hours, consistent with the 2008 California Title 24 requirements, section 150(k)13 exception 2.

Luminous Efficacy, Output and Zonal Lumen Density Requirements: DIRECTIONAL RESIDENTIAL Luminaires

Note: Luminaire types denoted as directional on the first page of this specification shall be evaluated based on luminaire photometry.

The performance values in this section pertain to the performance of the entire luminaire, including optics.

Luminaire Type	ENERGY STAR Requirements			Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
	Luminaire Efficacy	Luminaire Minimum Light Output	Luminaire Zonal Lumen Density Requirement		
Cove Mount	45 lm/W	<p>Luminaire shall deliver a minimum of 200 lumens (initial) per lineal foot.</p> <p>The minimum required light output (in lumens) is calculated by dividing the total luminaire length in inches by 12, then multiplying the result by 200.</p> <p>Note: The equation applies to all luminaire configurations. For rectangular geometries the "measured luminaire length" is the longest dimension of the luminaire. For circular geometries the "measured luminaire length" is the diameter. For linear track luminaires the "measured luminaire length" is the track length.</p>	Luminaire shall deliver a minimum of 35% of total lumens within the 120°-150° zone (vertical angles).	<p>Fluorescent: IES LM-41-98</p> <p>Solid State: IES LM-79-08</p> <p>High Intensity Discharge: IES LM-46-04</p> <p>ANSI C78.81-2010 (for T8)</p> <p>IEC 60081 data sheets (for T5)</p>	<p>Laboratory test results shall be produced using the specific lamp and ballast or LED package(s), LED module(s) or LED array(s) and LED driver combination that will be used in production.</p> <p>Linear fluorescent luminaires which do not ship with lamps shall be tested using lamps compliant with ANSI C78.81-2010 (for T8) or IEC 60081 data sheets (for T5).</p> <p>Fluorescent luminaires with ballast(s) capable of operating multiple fluorescent lamp types shall be tested either with the lamp(s) shipped with the luminaire, or if a lamp is not supplied, with one of the lamp types detailed on the packaging.</p> <p>High intensity discharge luminaires with ballast(s) capable of operating multiple lamp types shall be tested with the lamp(s) shipped with the luminaire.</p> <p>For downlights, one trim ring and one reflector may be used with the three luminaire samples.</p> <p>Sample Size: ≥ 3 complete luminaires.</p> <p>Passing Test: all luminaires shall pass.</p>
Downlights: <ul style="list-style-type: none"> • recessed • surface • pendant • SSL retrofits 	42 lm/W	<p>≤ 4.5" aperture: 345 lumens (initial)</p> <p>> 4.5" aperture: 575 lumens (initial)</p>	Luminaire shall deliver a minimum of 75% of total initial lumens within the 0-60° zone (axially symmetric about the nadir)		
Accent Lights (including line voltage track heads & directional ceiling fan light kits)	35 lm/W	Luminaire shall deliver a minimum of 200 lumens (initial) per head.	Luminaire shall deliver a minimum of 80% within the 0-40° zone (axially symmetric about the center of the beam).		

Under Cabinet	29 lm/W	<p>Luminaire shall deliver a minimum of 125 lumens (initial) per lineal foot.</p> <p>The minimum required light output (in lumens) is calculated by dividing the luminaire length in inches by 12, then multiplying the result by 125.</p> <p>Note: The equation applies to all luminaire configurations. For rectangular geometries the "measured luminaire length" is the longest dimension of the luminaire. For circular geometries the "measured luminaire length" is the diameter. For linear track luminaires the "measured luminaire length" is the track length.</p>	<p>Referring to the plane perpendicular to the length of the luminaire, the luminaire shall deliver a minimum of 60% of total initial lumens within the 0-60° zone (symmetric about the nadir) and a minimum of 12.5% of total initial lumens within the 60-90° zone aimed toward the backsplash.</p> <p>Manufacturer shall provide instructions with the luminaire noting which direction to install the luminaire to ensure this performance.</p>		
Outdoor Post-Mounted Decorative Luminaires (Note: for mounting between 4 feet and 10.5 feet above grade)	35 lm/W	Luminaire shall deliver a minimum of 300 lumens (initial).	<p>Luminaire shall deliver 95% of total lumens within the 0°- 85° zone (symmetric about the nadir). No greater than 1% of total luminaire lumens may be emitted above 90°.</p>	Fluorescent: IES LM-10-96 Solid State: IES LM-79-08 High Intensity Discharge: IES LM-31-95	
Inseparable SSL Luminaire (SSL luminaire types not otherwise noted in this table)	70 lm/W	None	None	IES LM-79-08	

Note: On June 8, 2010, EPA held a [webinar](#) during which the Agency presented an analysis of luminaire efficacy values found among currently qualified fluorescent and solid state luminaires. The above performance levels – some unchanged from the SSL v1.1 specification – represent what is both cost effective and broadly accessible.

Noting partner interest in the potential for qualification of some of the above luminaire types using high intensity discharge lamps, particularly ceramic metal halide, the above table has been expanded to include appropriate test procedures for that technology. Other tables have been adjusted accordingly; stakeholders are encouraged to review the related note boxes for details.

EPA notes that IES LM-41-98 has been automatically withdrawn by the Illuminating Engineering Society because it is more than 10 years old and in need of renewal by the IES Testing Procedures Committee. The Agency calls partners' attention to the need to have absolute photometry explicitly included in this method of measurement upon its renewal. While the current language includes methodology which could be employed to test luminaires using absolute photometry, this method of testing is not explicitly stated. EPA advises fluorescent manufacturing partners that qualification of luminaires using LM-41 will not take place until the method of measurement is renewed.

In response to technical guidance received from testing laboratories, the zonal lumen density requirements for Outdoor Post-Mounted Decorative Luminaires have been adjusted to indicate an upper limit to the number of lumens (1%) which may be measured above 90°.

In response to feedback from fluorescent luminaire manufacturers that the under cabinet zonal lumen density requirements were unclear and/or too restrictive, EPA revisited these requirements by conducting photometric testing on (12) ENERGY STAR qualified fluorescent under cabinet luminaires marketed for consumer use. Eleven models were found to meet the above zonal lumen density requirements; one unit failed the 0-60° zone requirement. Out of the (12) units tested, one model did not meet the efficacy requirement. In total, (10) out of (12) under cabinet fluorescent models passed all of the above; the Agency has found no reason to deviate from the proposed requirements.

To address concerns about the language being impractical or without benefit for consumers, the revised proposal removes any requirement for zonal lumen output in the 60-90° zone aimed towards the room, output which would be a potential source of glare. Currently qualified SSL under cabinet luminaires will meet the proposed requirements. These revised requirements direct the majority of light towards the work surface while maintaining some output towards the backsplash. Language has been inserted requiring the manufacturer to provide instructions regarding the proper installation orientation of the luminaire.

All language regarding zonal lumen output symmetry has been clarified, indicating to which plane(s) the angle references apply.

Regarding the zonal lumen density requirement for accent lights (formerly "surface mount with directional head(s)"), EPA believes that the performance requirement detailed in draft 1 – which would allow 85% of total lumens to be emitted over the full 180 degree hemisphere forward of the fixture – is not a sufficient requirement to ensure that these luminaire types would satisfy consumers by creating a distinct beam typically delivered by incandescent sources. Recognizing that LEDs are directional, many LED packages exhibit a very wide intensity distribution. The Agency believes the ENERGY STAR performance requirement should provide beam performance more closely resembling that of reflector lamps, and has therefore modified the language above. The Agency seeks industry input toward further refining this requirement.

The requirement for inseparable SSL luminaires:

- is intended for luminaires (including non-directional) which must be evaluated by luminaire photometry because the luminaire has been constructed in a way which will not allow for the removal of the LED packages, driver circuitry and heat sink (i.e. the LED light engine) for measurement independent of the luminaire; and,
- does not apply to luminaires employing LED light engines replaceable or upgradeable without cutting wires or using solder; and,
- does not apply to any luminaire type otherwise detailed in the above table; and,
- is in alignment with the intended progression to Category B in the SSL v1.1 specification: luminaire efficacy of 70 lm/W, no zonal lumen density requirements; and,
- is generally more stringent because unlike incumbent technologies, inseparable SSL luminaires offer no pathway for the consumer/end user to replace or upgrade the enclosed light source; the entire luminaire must be replaced.

Luminous Efficacy, Output and Zonal Lumen Density Requirements: DIRECTIONAL COMMERCIAL Luminaires

Note: Luminaire types denoted as directional on the first page of this specification shall be evaluated based on luminaire photometry. The performance values in this section pertain to the performance of the entire luminaire, including optics.

(Note: ENERGY STAR qualification is available for only the following commercial luminaire types. Other commercial luminaire types will not be reviewed for qualification.)

Luminaire Type	ENERGY STAR Requirements			Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
	Luminaire Efficacy	Luminaire Minimum Light Output	Luminaire Zonal Lumen Density Requirement		
Portable Desk Task	29 lm/W	Luminaire shall deliver a minimum of 200 lumens (initial).	Luminaire shall deliver a minimum of 85% of total lumens (initial) within the 0-60° zone (symmetric about the center of the beam).	Fluorescent: IES LM-41-98 Solid State: IES LM-79-08	Laboratory test results shall be produced using the specific lamp and ballast or LED package(s), LED module(s) or LED array(s) and LED driver combination that will be used in production.
Downlights: • recessed • surface • pendant • SSL retrofits	42 lm/W	≤ 4.5" aperture: 345 lumens (initial) > 4.5" aperture: 575 lumens (initial)	Luminaire shall deliver a minimum of 75% of total lumens (initial) within the 0-60° zone (axially symmetric about the nadir).	High Intensity Discharge: IES LM-46-04 ANSI C78.81-2010 (for T8)	Linear fluorescent luminaires which do not ship with lamps shall be tested using lamps compliant with ANSI C78.81-2010 (for T8) or IEC 60081 data sheets (for T5). Fluorescent luminaires with ballast(s) capable of operating multiple fluorescent lamp types shall be tested either with the lamp(s) shipped with the luminaire, or if a lamp is not supplied, with one of the lamp types detailed on the packaging.
Under Cabinet	29 lm/W	Luminaire shall deliver a minimum of 125 lumens (initial) per lineal foot. The minimum required light output (in lumens) is calculated by dividing the luminaire length in inches by 12, then multiplying the result by 125. Note: The equation applies to all luminaire configurations. For rectangular geometries the "measured luminaire length" is the longest dimension of the luminaire. For circular geometries the "measured luminaire length" is the diameter. For linear track luminaires the "measured luminaire length" is the track length.	Referring to the plane perpendicular to the length of the luminaire, the luminaire shall deliver a minimum of 60% of total lumens (initial) within the 0-60° zone (symmetric about the nadir) and a minimum of 12.5% of total lumens (initial) within the 60-90° zone aimed towards the backsplash. Manufacturer shall provide instructions with the luminaire noting which direction to install the luminaire to ensure this performance.	IEC 60081 data sheets (for T5)	High intensity discharge luminaires with ballast(s) capable of operating multiple lamp types shall be tested with the lamp(s) shipped with the luminaire. For downlights, one trim ring and one reflector may be used with the three luminaire samples. Sample Size: ≥ 3 complete luminaires. Passing Test: all luminaires shall pass.

Note: Noting partner interest in the potential for qualification of some of the above luminaire types using high intensity discharge lamps, specifically ceramic metal halide, the above table has been expanded to include appropriate test procedures for that technology.

EPA notes that IES LM-41-98 has been automatically withdrawn by the Illuminating Engineering Society because it is more than 10 years old and in need of renewal by the IES Testing Procedures Committee. The Agency calls partners' attention to the need to have absolute photometry explicitly included in this method of measurement upon its renewal. While the current language includes methodology which could be employed to test luminaires using absolute photometry, this method of testing is not explicitly stated. EPA advises fluorescent manufacturing partners that qualification of luminaires using LM-41 will not take place until the method of measurement is renewed.

Under cabinet zonal lumen density requirements have been revised, consistent with revisions in this draft to the residential under cabinet requirements.

Consistent with this specification's testing approach to commercial grade products, Portable Desk Task Lights, above, are subject to luminaire photometry, while residential grade task lights may be evaluated by source photometry (see non-directional residential requirements on page 10).

Light Source Life Requirements: All Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> • linear • compact • self ballasted compact (GU24) • circline 	<p>For lamps shipped with luminaires, the average rated life of the source shall be $\geq 10,000$ hours.</p> <p>If the lamp is not shipped with the luminaire, product packaging shall meet the requirements set forth in the "Product Labeling & Packaging Requirements" section of this spec.</p> <p><u>Exception:</u> Covered and dimmable versions of GU24 based integrated lamps are required to meet reduced life requirements as outlined in qualification requirements for those lamps.</p> <p>Conditional qualification may be granted if both of the following are met:</p> <ol style="list-style-type: none"> 1. Testing has been completed for at least 40% of rated life. 2. A date for testing completion has been established by the test laboratory. <p>Conditional qualification shall be immediately withdrawn if final testing results do not meet the above requirement.</p> 	<p>Linear & circline: IES LM-40-01</p> <p>Compact & self ballasted compact: IES LM-65-01</p> <p>IES LM-47-01</p>	<p>Laboratory test results shall be produced using the specific lamp that will operate in the luminaire and either the ballast that will operate in the luminaire or a commercially-available ballast that meets the applicable ANSI ballast requirements, if applicable, for the light source being tested.</p> <p>Sample Size: ≥ 10 lamps shall be tested.</p> <p>Passing Test: $\geq 50\%$ of the sample set shall be functioning at the lifetime requirement.</p>
High Intensity Discharge <ul style="list-style-type: none"> • metal halide • ceramic metal halide • high pressure sodium 			
Halogen Incandescent (outdoor only)	<p>Lamps shipped with luminaires shall feature a rated life of $\geq 3,000$ hours.</p>	IES LM-49-01	<p>Laboratory test results shall be produced using the specific lamp that will operate in the luminaire (as applicable).</p> <p>Sample Size: ≥ 10 lamps shall be tested.</p> <p>Passing Test: $\geq 50\%$ of the sample set shall be functioning at the lifetime requirement.</p>
Solid State	<p>Luminaires shall meet the following L_{70} rated lumen maintenance life values:</p> <ul style="list-style-type: none"> • 25,000 hours for residential grade indoor luminaires • 35,000 hours for residential grade outdoor luminaires • 35,000 hours for commercial grade luminaires <p>Lifetime claims in excess of the above requirements shall be substantiated with LM-80-08 test report data and lumen maintenance projections based upon guidelines in IES TM-21-11.</p> <p>Refer to Lumen Maintenance Requirements in the next section.</p>		

Note: Minor changes have been made to above to clarify conditional qualification requirements for fluorescent and HID, and to eliminate confusion between fluorescent and halogen requirements and testing guidance.

Also, in response to partner concerns about limitations to lifetime claims outlined in draft 1, EPA has revised the solid state requirements to allow life claims exceeding the above specification requirements so long as those claims can be substantiated through test data (i.e. LM-80) and projections governed by IES TM-21-11 (currently in draft).

Lumen Maintenance Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> linear compact self ballasted compact (GU24) circline 	<p>For lamps indicated on the luminaire packaging or shipped with the luminaire, the lamp shall have an average rated lumen maintenance of at least 80% of initial lamp lumens at 40% (4,000 hours minimum) rated lamp life.</p>	<p>Linear & circline: IES LM-40-01 IES LM-09-99</p>	<p>Laboratory test results shall be produced using the specific lamp that will operate in the luminaire and either the ballast that will operate in the luminaire or a commercially-available ballast that meets the applicable ANSI ballast requirements, if applicable, for the light source being tested.</p> <p>Sample Size: ≥ 10 lamps shall be tested.</p>
High Intensity Discharge <ul style="list-style-type: none"> metal halide ceramic metal halide high pressure sodium 		<p>Compact & self ballasted compact: IES LM-65-01 IES LM-66-00</p> <p>IES LM-47-01</p>	
Solid State Option 1: Component Performance (select either option 1 or option 2, below)	<p>The LED package(s) / LED module(s) / LED array(s) shall deliver, <i>in situ</i>:</p> <ul style="list-style-type: none"> L₇₀(25,000 hours) for residential indoor L₇₀(35,000 hours) for residential outdoor, or commercial <p>Lumen maintenance projections shall be based on guidance from IES TM-21, the <i>in situ</i> TMP_{LED} temperature of the hottest LED in the luminaire, the forward drive current applied to each LED package/module/array model ("device"), and the IES LM-80 test report for the device which, in addition to LM-80 reporting requirements, shall provide each of the following:</p> <ul style="list-style-type: none"> sampling method and sample size (per LM-80 section 4.3) test results for each T_s and drive current combination description of device including model number and whether device is an LED package, module or array (see Definitions) ANSI target, and calculated CCT value(s) for each device in sample set Δ u'v' chromaticity shift value on the CIE 1976 diagram for each device in sample set a detailed rationale, with supporting data, for application of results to other devices (e.g. LED packages with other CCTs) <p>Access to the TMP_{LED} for the hottest LED may be accomplished via a hole in the luminaire housing, tightly resealed with a suitable sealant if created for purposes of testing.</p> <p>All thermocouple attachments shall be photographed.</p>	<p>Measurement: IES LM-80-08</p> <p>Lumen maintenance projection: IES TM-21-11 (in draft)</p> <p>Note: EPA is following industry efforts to develop the above test procedure:</p> <p><i>Projecting Long Term Lumen Maintenance of LED Packages</i></p> <p>Upon its publication, EPA intends to reference this technical memorandum.</p> <p>Chromaticity specifications: ANSI C78.377-2008</p> <p>CCT calculation: CIE 15.2004</p>	<p>For downlights, one trim ring and one reflector may be used with the three luminaire samples.</p> <p>Luminaire Sample Size: three complete luminaires.</p> <p>LM-80 Sample Size: minimum sample size of 25 units for LED packages, or 10 units for LED modules or arrays, for each T_s and drive current combination. Each sample set may be composed entirely of one target CCT, or may be split between no more than two adjacent target CCT values as outlined in ANSI C78.377 (e.g. 2700 and 3000K, or 3500K and 4000K).</p> <p>Passing Test: all of the conditions below shall be met. If any of the conditions are not met, the component performance option may not be used and the applicant shall use Option 2, below, for compliance.</p> <ol style="list-style-type: none"> In each sample luminaire, the TMP_{LED} temperature, measured <i>in situ</i>, is less than or equal to the temperature(s) specified in the LM-80 test report for the corresponding or higher drive current, within the manufacturer's specified operating current range. The drive current measured in the luminaire is less than or equal to the drive current specified in the LM-80 test report at the corresponding temperature or higher. Guidance from TM-21 indicates L₇₀ projection meets or exceeds ENERGY STAR requirements.

<p>Solid State Option 2: Luminaire or LED Light Engine Performance</p> <p>(select either option 2 or option 1, above)</p>	<p>Directional luminaires: the luminaire shall deliver at 6,000 hours the fraction of initial lumens specified below:</p> <p>Non-directional luminaires: each LED light engine shall deliver at 6,000 hours the fraction of initial lumens specified below:</p> <ul style="list-style-type: none"> • indoor luminaires: $\geq 91.8\%$ • outdoor luminaires: $\geq 94.1\%$ • commercial luminaires: $\geq 94.1\%$ <p>These percentages are based on exponential decay functions for 25,000 hours and 35,000 hours to determine the 6,000 hour lumen maintenance necessary to achieve those rated lumen maintenance life values.</p>	<p>Directional luminaires: IES LM-79-08</p> <p>Non-directional luminaires: IES LM-xx-1x</p> <p>Interim operation: ANSI/UL 1598-2008 UL 153-2002</p> <p>NOTE: EPA is working with industry to develop the above test procedure:</p> <p><i>IES Approved Method for the Characterization of LED Light Engines and Integrated LED Lamps for Electrical and Photometric Properties as a Function of Temperature</i></p>	<p>For downlights, one trim ring and one reflector may be used with the three luminaire samples.</p> <p>Luminaire shall be operated continuously in accordance with ANSI/UL 1598-2008 or UL 153-2002 during the interim 6,000 hours; any deviations from this shall be reported. Also, LED light engines shall be operated continuously <i>in situ</i> during the interim 6,000 hours. During initial and final LM-xx measurements, T_b temperature shall be controlled to match T_b temperature measured when LED light engine is operated <i>in situ</i>.</p> <p>Sample Size: Directional: three complete luminaires.</p> <p>Non-directional: three LED light engines and the necessary number of luminaires required to operate the engines continuously <i>in situ</i>.</p> <p>Passing Test: all luminaires or LED light engines shall pass.</p>
<p>Halogen Incandescent (outdoor only)</p>	<p>Exempt</p>		

Note: Responding to partner concerns about short-term implementation of option 2 as the sole option for satisfying solid state lumen maintenance requirements, EPA has elected to keep both options in place until industry standards for whole-luminaire measurement and projection can be completed, and until industry gains more experience evaluating luminaire lumen maintenance in this manner. Once this specification is finalized, in a future revision the Agency will revisit the viability of employing whole-luminaire testing, or LED light engine testing as the approach to evaluating lumen maintenance. The Illuminating Engineering Society's Testing Procedures Committee has recently convened a working group tasked with developing LM-XX, IES Approved Method for Measuring Lumen Maintenance of LED Luminaires. Please note also that while option 2 above references an LED light engine test procedure in development for photometric and electrical evaluation, another working group is developing a lumen maintenance test procedure for LED light engines which, once available, EPA will evaluate for inclusion in future specification revisions.

In parallel with the development of this specification, EPA is researching LM-80 sample sizes, and issues related to the composition of those sample sets in terms of the correlated color temperature of the LED packages tested, and the influence of binning parameters on LM-80 test results. Also being explored are rules for successor packages and successor arrays, to guide certification bodies who will determine if generational changes represent modest incremental improvements, or major advancements in performance which warrant new LM-80 testing. EPA is also exploring the application of LM-80 test reports across various CCTs, when one report may be allowed to represent the performance of another non-tested LED package or module. Similarly, component substitution is being reexamined: under what circumstances one LED package may be replaced with another (from a different manufacturer than the original qualification, for instance) without requalification of the luminaire. The Agency will issue guidance to the certification bodies upon completion of the above. In the interim, the above LM-80 sample sizes are carried over from the SSL v1.1 specification, with additional proposed requirements regarding the color composition of those sample sets. LM-80 test report requirements beyond the reporting requirements outlined in the test method are also detailed.

EPA understands that work on IES TM-21-11, a standardized method for projecting long term lumen maintenance performance of LED packages and modules based on 6,000 hours of collected data, will be completed in early 2011 in time for the effective date of this specification. Should delays occur, EPA proposes to employ the extrapolation methodology outlined in the SSL V1.1 specification, until TM-21-11 is completed. Above language referencing TM-21-11 will be further refined in a subsequent draft of this specification once the document is available for review.

Option 1 requirement language has been revised to require submission of a photo illustrating any holes placed in tested units to allow for insertion of thermocouples.

For fluorescent and HID, lumen maintenance requirements may no longer be satisfied through the use of ISO 9000 registered vendors. Test data from these facilities will not meet the new and enhanced testing requirements being implemented across all ENERGY STAR labeled products. Laboratories that provide test results for lumen maintenance must have a scope of accreditation to do so. EPA has determined that compliance with the lumen maintenance requirement continues to be a problem with the program. As an example, through five rounds of EPA's quality assurance testing for residential light fixtures (QA4), the statistically most common performance failures have been (in order): 4,000 hour and 1,000 hour lumen maintenance, and correlated color temperature.

**Correlated Color Temperature (CCT) Requirements: All Indoor Luminaires
(Exemption: Outdoor Luminaires)**

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> linear compact self ballasted compact (GU24) circline 	<p>Lamps shipped with luminaires shall have one of the following nominal correlated color temperatures (CCT):</p> <ul style="list-style-type: none"> 2700 K 3000 K 3500 K 4100 K 5000 K (commercial only) 	<p>Measurement (linear & circline): IES LM-9-09</p> <p>Measurement (compact & self ballasted compact): IES LM-66-00</p> <p>Calculation: CIE 15.2004</p>	<p>Laboratory test results shall be produced using the specific lamp that will operate in the luminaire and either the ballast that will operate in the luminaire or a commercially-available ballast that meets the applicable ANSI ballast requirements, if applicable, for the light source being tested.</p> <p>Sample Size: ≥ 10 lamps shall be tested.</p> <p>Passing Test: ≥ 90% of the lamps tested fall within a 7-step ANSI MacAdam ellipse for the designated CCT.</p>
High Intensity Discharge <ul style="list-style-type: none"> metal halide ceramic metal halide high pressure sodium 	<p>Lamps shipped with luminaire shall consistently meet the above requirement, as verified by consistency data provided by the lamp vendor to the luminaire manufacturer.</p> <p>If the lamp is not shipped with the luminaire, product packaging shall meet the requirements set forth in Product Labeling & Packaging Requirements.</p>	<p>Measurement: IES LM-51-00</p> <p>Calculation: CIE 15.2004</p>	
Solid State	<p>The luminaire (directional luminaires) or LED light engine (non-directional luminaires) shall have one of the following nominal correlated color temperatures (CCTs):</p> <ul style="list-style-type: none"> 2700 K 3000 K 3500 K 4000 K 5000 K (commercial only) <p>The luminaire or LED light engine shall also fall within the corresponding 7-step chromaticity quadrangles as defined in ANSI C78.377-2008.</p>	<p>Chromaticity specifications: ANSI C78.377-2008</p> <p>Measurement (directional): IES LM-79-08</p> <p>Measurement (non-directional): IES LM-xx-1x</p> <p>NOTE: EPA is working with industry to develop the above test procedure:</p> <p><i>IES Approved Method for the Characterization of LED Light Engines and Integrated LED Lamps for Electrical and Photometric Properties as a Function of Temperature</i></p> <p>Calculation: CIE 15.2004</p>	<p>For downlights, one trim ring and one reflector may be used with the three luminaire samples.</p> <p>LED light engine CCT shall meet the requirement as determined by evaluating the <i>in situ</i> T_b temperature against the LED light engine LM-xx test report.</p> <p>Sample Size: three complete luminaires, or three LED light engines.</p> <p>Passing Test: all luminaires shall pass.</p>

Note: EPA received feedback from partners requesting expansion of CCT values allowed for qualification, and also received support for an upper limit of 4100 Kelvin. EPA is concerned that with the increased efficacy requirements, allowing CCTs above the 4100 Kelvin residential limit may lead manufacturers to shift residential products towards high CCTs which more easily achieve compliance with efficacy requirements, but are generally less preferred by consumers. The Agency has examined the issue and determined that expansion is appropriate for commercial luminaire types, as reflected above.

Recognizing that ANSI C78.377-2008 provides guidance on an alternative “flexible CCT system”, EPA does not feel this is appropriate for ENERGY STAR specifications as more often than not, qualified products will be installed in spaces which also feature other lighting products. Allowing a flexible CCT system permitting any CCT at 100K increments between 2700 and 6500 Kelvin will likely complicate purchasing decisions for consumers and end users, and make it difficult to ensure the uniform application of one color temperature within a space, leading to consumer dissatisfaction.

For fluorescent and HID, CCT requirements may no longer be satisfied through the use of ISO 9000 registered vendors. Test data from these facilities will not meet the new and enhanced testing requirements being implemented across all ENERGY STAR labeled products. Laboratories that provide test results for CCT must have a scope of accreditation to do so. EPA has determined that compliance with the CCT requirement continues to be a problem with the program. As an example, through five rounds of EPA’s quality assurance testing for residential light fixtures (QA4), the statistically most common performance failures have been (in order): 4,000 hour and 1,000 hour lumen maintenance, and correlated color temperature.

Technical note #4 in draft 1 has been replaced by clarifying language inserted in the above requirements for fluorescent and high intensity discharge sources

**Color Rendering Requirements: All Indoor Luminaires
(Exemption: Outdoor Luminaires)**

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> • linear • compact • self ballasted compact (GU24) • circline 	Lamps shipped with luminaires shall meet or exceed $R_a \geq 80$.	Measurement (linear & circline): IES LM-9-09 Measurement (compact and self ballasted compact): IES LM-66-00 Calculation: CIE 13.3-1995	Laboratory test results shall be produced using the specific lamp that will operate in the luminaire and either the ballast that will operate in the luminaire or a commercially-available ballast that meets the applicable ANSI ballast requirements, if applicable, for the light source being tested. Sample Size: ≥ 10 lamps shall be tested. Passing Test: $\geq 80\%$ of the samples shall achieve the required color rendering index value.
High Intensity Discharge <ul style="list-style-type: none"> • metal halide • ceramic metal halide • high pressure sodium 		Measurement (high intensity discharge): IES LM-51-00 Calculation: CIE 13.3-1995	
Solid State	The luminaire (directional luminaires) or LED light engine (non-directional luminaires) shall meet or exceed $R_a \geq 80$.	Directional measurement: IES LM-79-08 Non-Directional (LED light engine) measurement: IES LM-xx-1x NOTE: EPA is working with industry to develop the above test procedure: <i>IES Approved Method for the Characterization of LED Light Engines and Integrated LED Lamps for Electrical and Photometric Properties as a Function of Temperature</i> Calculation: CIE 13.3-1995	For downlights, one trim ring and one reflector may be used with the three luminaire samples. LED light engine CRI shall meet the requirement as determined by evaluating the <i>in situ</i> T_b temperature against the LED light engine LM-xx test report. Sample Size: three complete luminaires, or three LED light engines. Passing Test: all luminaires or LED light engines shall pass.

Note: Draft 1 included a proposal to require a positive R_9 value in addition to the minimum R_a value of 80. EPA is seeking a color rendering metric that is a better indicator of a light source's naturalness, vividness, and color discrimination properties than the Color Rendering Index (CRI). For this reason, EPA included a requirement for both general CRI (R_a) and special CRI R_9 in draft 1 based on the inclusion of R_9 in the Integral LED Lamps specification. However, after draft 1 was released, EPA learned of data that raise questions about the incremental value of using the R_9 criterion in addition to general CRI. These data show that sources with high R_9 values are no better for color discrimination on the Farnsworth-Munsell 100 Hue test than sources with low values. Also, R_9 was shown to be sometimes more, but sometimes less, predictive than general CRI of a light source's ability to render objects naturally and vividly; the predictive value depended on the color of the object being illuminated. For these reasons, in draft 2 EPA has reverted to a general CRI requirement alone, and proposes to annually revisit the topic of color rendering performance requirements as industry continues development of a successor to the CRI.

Color Angular Uniformity Requirements: Directional Solid State Indoor Luminaires Only (Exemption: Outdoor Luminaires)

ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
The variation of chromaticity in different directions (i.e., with a change in viewing angle) shall be within 0.004 from the weighted average point on the CIE 1976 (u',v') diagram.	Measurement: IES LM-79-08 & IES LM-58-94 Calculations: CIE 15: 2004	Vertical angular scanning resolution shall be 1 degree on the 0 and 90 degree vertical planes, and $\Delta u', v'$ distance shall be reported for each vertical angle measured. Sample Size: one complete luminaire. Passing Test: the luminaire shall pass.

Note (repeated from draft 1): Variation in chromaticity by viewing angle is not found in fluorescent sources but can be a problem with LEDs and solid state luminaires. The above requirement is for directional luminaires only since the projection of color striations onto a work surface (from a downlight, under cabinet luminaire or desk task light) would be potentially noticeable and distracting. While this phenomenon is most pronounced and potentially problematic in the near field, standards only provide for far field measurements, therefore, this approach may only address luminaires with the most obvious deficiencies. EPA requests partner input on the utility of this approach.

Color Maintenance Requirements: Solid State Indoor Luminaires Only (Exemption: Outdoor Luminaires)

ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
<p>The change of chromaticity over the first 6,000 hours of luminaire operation shall be within 0.007 on the CIE 1976 (u',v') diagram, as demonstrated by either:</p> <ul style="list-style-type: none"> the IES LM-80 test report for the employed LED package/array/module model, or as demonstrated by a comparison of luminaire chromaticity data in LM-79 reports at zero and 6,000 hours. 	<p>IES LM-80-08 IES LM-79-08 Interim operation: ANSI/UL 1598-2008 UL 153-2002</p>	<p>Laboratory test results shall be produced using the specific lamp and ballast or LED package(s), LED module(s) or LED array(s) and LED driver combination that will be used in production.</p> <p>For the LM-79 option, luminaire shall be operated continuously in accordance with ANSI/UL 1598-2008 or UL 153-2002 during the interim 6,000 hours; any deviations from this shall be reported. Also, LED light engines shall be operated continuously <i>in situ</i> during the interim 6,000 hours. During initial and final LM-xx measurements, T_b temperature shall be controlled to match T_b temperature measured when LED light engine is operated <i>in situ</i>.</p> <p>Sample Size (LM-80 option): same as Lumen Maintenance, Option 1.</p> <p>Sample Size (LM-79 option): three complete luminaires, or three LED light engines and the necessary number of luminaires required to operate the engines continuously <i>in situ</i>.</p> <p>Passing Test (LM-80 option): for all LM-80 samples, at any measurement point from zero through 6,000 hours, the distance of the chromaticity coordinates from the initial (zero-hour) chromaticity coordinates shall not exceed 0.007 at the temperature(s) adjacent to the measured <i>in-situ</i> TMP_{LED} temperature, and at the corresponding drive current.</p> <p>Example 1: an LM-80 test report provides data at $T_s = 55^\circ C, 85^\circ C$ and $105^\circ C$, and the measured <i>in-situ</i> TMP_{LED} temperature value is $89^\circ C$. Neither the $85^\circ C$ nor the $105^\circ C$ LM-80 data may show chromaticity shift exceeding 0.007 at any measurement point from zero through 6,000 hours, for the corresponding drive current. The LM-80 chromaticity data at $55^\circ C$ is disregarded.</p> <p>Example 2: an LM-80 test report provides data at $T_s = 58^\circ C, 87^\circ C$ and $106^\circ C$, and the measured <i>in-situ</i> TMP_{LED} temperature value is $53^\circ C$. The LM-80 data at $58^\circ C$ may not show chromaticity shift exceeding 0.007 at any measurement point from zero through 6,000 hours, for the corresponding drive current. The LM-80 chromaticity data at $87^\circ C$ and $106^\circ C$ is disregarded.</p> <p>Passing Test (LM-79 option): at 6,000 hours the distance of the chromaticity coordinates from the initial chromaticity coordinates shall not exceed 0.007. The output at zero degrees on both vertical planes shall be compared.</p>

Note: Draft 1 required that chromaticity not shift more than 0.007 over the life of the product. Recognizing that full life testing (i.e. 25,000 hours, 35,000 hours) is not required for ENERGY STAR qualification, the above requirement has been adjusted to apply to the minimum required testing duration detailed in IES LM-80 (6,000 hours). EPA has reviewed all LM-80 test reports received to date by the ENERGY STAR program, to understand what chromaticity shifting trends can be found among the existing data. During this review it was noted that for some LED packages or modules, comparing like drive currents, high temperature operation (e.g. $T_s = 105^\circ C$) lead to greater chromaticity shifting, however in other instances greater shifting was found at lower T_s values.

As in draft 1, the revised proposal above (option 1) is to analyze LM-80 chromaticity shift data. The passing test is intended to ensure that during the portion of life evaluated by LM-80, chromaticity shifting does not exceed the value previously expected over lifetime of the luminaire.

Lamp Shipment Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> • compact • self ballasted compact (GU24) • circline High Intensity Discharge <ul style="list-style-type: none"> • metal halide • ceramic metal halide • high pressure sodium Halogen Incandescent (outdoor only)	<p>All luminaires shall be shipped with a lamp for each lampholder.</p> <p><u>Exceptions:</u></p> <ol style="list-style-type: none"> 1. Linear fluorescent luminaires 2. Outdoor luminaires employing ANSI E26 lampholders. <p>Lamps shall utilize an ANSI/IEC standardized lamp base configuration.</p> <p>Fluorescent and high intensity discharge lamps or lamp bases shall be labeled with the lamp manufacturer name, wattage, correlated color temperature, and color rendering index. Alternatively information may be included on lamp packaging only in instances where a lamp's physical dimensions will not allow lamp or lamp base labeling.</p> <p>In addition, lamp dimensions and electrical parameters shall either:</p> <ul style="list-style-type: none"> • Meet the requirements of an ANSI/IEC standardized lamp specification sheet if an applicable standard exists; or, • If no ANSI/IEC lamp standard exists (e.g., a spiral compact fluorescent lamp), provide a manufacturer lamp specification sheet that describes the following (use the ANSI lamp data sheets found in ANSI C78.901-2005 and C78.81-2010 as a reference for the format and type of information requested): <ol style="list-style-type: none"> 1. lamp description, including lamp model number, nominal wattage bulb designation / lamp size (i.e. T4, T5, T8) and lamp base type as defined by ANSI C81.61-2009; <p>or,</p> <p>IEC 60061-1(i.e. 2G13, GR10q, etc.), starting circuit application (i.e., rapid start, preheat, etc.)</p> <ol style="list-style-type: none"> 2. Dimensional characteristics, including diagram 3. Lamp operating characteristics, including: approximate wattage (W), voltage(V), current (A) 	<p>Lamp base configuration: ANSI C81.61-2009</p> <p>Lamps compliant with an ANSI-IEC standard (for lamp dimensions and electrical parameters):</p> <p>For compact fluorescent lamps: ANSI C78.901-2005; IEC 60901</p> <p>For linear lamps: ANSI C78.81-2010; IEC 60081</p> <p>Lamps not compliant with an ANSI-IEC standard (for lamp dimensions and electrical parameters):</p> <p>ANSI C78.901-2005; ANSI C78.81-2010</p> <p>(used as a reference for the format and type of information required on a custom lamp specification sheet)</p>	None.
Solid State	Complete light source components shall be provided with the luminaire.	No standard available.	No documentation required.

Note: The above language has been clarified to allow labeling of the lamp glass in instances where the lamp base is not large enough to permit labeling. A provision has also been included for instances where the physical dimensions of the lamp do not allow labeling anywhere on the lamp. Some reformatting has occurred.

The lamp shipment requirement is now extended to fluorescent recessed luminaires to ensure that those luminaires provide the same performance as tested and qualified.

Finally, the above clarifies that solid state fixtures must be shipped with all light source components included.

Electrical Performance Requirements

Source Start Time Requirements: Directional and Non-Directional Luminaires (Exemption: Outdoor Luminaires)

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> linear compact self ballasted compact (GU24) circline 	Light source shall remain continuously illuminated within one second of application of electrical power.	ANSI C82.11 Consolidated-2002 Section-5.2	Laboratory test results shall be produced using the specific lamp and ballast or LED package(s), LED module(s) or LED array(s) and LED driver combination that will be used in production. Sample Size: ≥ 3 lamps, lamp-ballast combinations, or LED package(s)/LED module(s)/LED array(s) and LED driver combinations shall be tested. Passing Test: all samples shall pass.
High Intensity Discharge <ul style="list-style-type: none"> metal halide ceramic metal halide high pressure sodium 		No standard available (as of September 2010). Note: For indoor luminaires EPA does not allow the starting times detailed in ANSI C82.4-2002.	
Solid State		No standard available (as of September 2010).	
Halogen Incandescent (outdoor only)		No standard available (as of September 2010).	

Source Run-Up Time Requirements: Directional and Non-Directional Luminaires (Exemption: Outdoor Luminaires)

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none">• linear• compact• self ballasted compact (GU24)• circline	Elapsed time for lamps to reach 90% of rated lumen output after application of electrical power shall be: <ul style="list-style-type: none">• ≤ 1 minute for non-amalgam lamps• ≤ 3 minutes for amalgam lamps	Linear & circline: No standard available (as of September 2010). Compact & self-ballasted compact: ANSI C78.5-2003, clause 4.8.	Laboratory test results shall be produced using the specific lamp and ballast or LED package(s), LED module(s) or LED array(s) and LED driver combination that will be used in production. Sample Size: ≥ 3 lamp-ballast combinations, or LED package(s)/LED module(s)/LED array(s) and LED driver combinations shall be tested.. Passing Test: all samples shall pass.
High Intensity Discharge <ul style="list-style-type: none">• metal halide• ceramic metal halide• high pressure sodium	Light source shall reach 90% of rated lumen output within one minute of application of electrical power.	No standard available (as of September 2010). Note: For indoor luminaires EPA does not allow the warm-up times detailed in ANSI C82.4-2002.	
Solid State		No standard available (as of September 2010).	
Halogen Incandescent (outdoor only)	Exempt		

Note: The Source Start Time Requirement language has been modified to clarify the requirement, and to apply the same requirement to all technologies employed for qualification of indoor luminaires; outdoor luminaires have been exempted from this requirement.

Recognizing that discharge sources can take a considerable amount of time to reach true full rated light output, the above Source Run-Up Time Requirements have been adjusted to require 90% lumen output within one minute, rather than full rated output; outdoor luminaires have been exempted from this requirement.

Also recognizing that elongated source run-up time can be a detractor to consumers, but noting that most lamp manufacturers have migrated to amalgam dosing of fluorescent lamps, EPA requests stakeholder feedback on the potential for updating the above 3 minute allowance for amalgam lamps to reflect the state of the art. Please note that the fluorescent run-up requirements above are borrowed from the ENERGY STAR CFL specification.

Regarding high intensity discharge indoor luminaires (e.g. ceramic metal halide), please note that EPA will not allow the elongated starting and run-up times detailed in ANSI C82.4-2002 to be used for qualification. However, the Agency is interested in ENERGY STAR qualification of products – regardless of technology – which meet this specification and have the potential to expand consumer use of energy efficient lighting. Therefore the restriction on the indoor use of high intensity discharge sources been removed in this second draft, providing a pathway for qualification should technical advancements related to start time and run-up time be addressed, making these technologies attractive for promotion to consumers.

References to OSHA NRTLs in the above sections have been removed. Going forward, these laboratories will be permitted to conduct testing to satisfy safety and related thermal testing requirements in this specification, but may not be used to conduct testing for non-safety criteria unless they are EPA-recognized with an appropriate scope of accreditation for each performance criterion.

Source Replaceability Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> • linear • compact • self ballasted compact (GU24) • circline High Intensity Discharge <ul style="list-style-type: none"> • metal halide • ceramic metal halide • high pressure sodium Halogen Incandescent (outdoor only)	<p>The luminaire's lampholder(s) shall be designed to accept lamps with ANSI/IEC standardized lamp base configurations for all applicable wattages. For example, if the ballast can operate lamps with multiple wattages (e.g., an 18W, 26W, or 32W lamp) then the lampholder shall be designed to accept lamps with ANSI/IEC standardized lamp base configurations for all three applicable wattages.</p> <p>Note: With the exception of halogen incandescent lamps used in outdoor models and some high intensity discharge luminaires, luminaires without dedicated ballasts and employing screw base lampholders (i.e. ANSI E26, E26d E12, E17, E39, E39d) are not eligible to earn the ENERGY STAR.</p>	<p>Lampholder configuration: ANSI/IEC C81.62-2009</p>	None.
Solid State: Non-Directional	<p>For non-directional luminaires, LED light engines shall make use of electrical interconnects which allow for consumer replacement of the engine without the cutting of wires or the use of solder.</p> <p>Luminaires which cannot meet this requirement are to be evaluated as inseparable SSL luminaires (see directional luminaire requirements below and throughout this specification).</p>	<p>No standard available (as of September 2010).</p> <p>Recommendations outlined in NEMA LSD 45-2009 shall be followed.</p>	
Solid State: Directional	Exempt.		

Note: This section title has been changed from Lampholder Requirements to reflect new language inserted for Solid State: Non-Directional.

By definition (see RP-16-10), LED light engines differ from integrated LED lamps only due to their lack of an ANSI standard base. Recognizing that LED light engines also need not assume ANSI standard lamp shapes, allowing for greater design flexibility and better thermal conductance with the luminaire, the above electrical connection language has been placed in draft 2 to gather industry input on the topic.

The Agency encourages stakeholder review of [NEMA LSD 45-2009, Recommendations for Solid State Lighting Sub-Assembly Interfaces for Luminaires](#), intended to serve as a starting point for industry development of SSL interconnect standards.

The Agency also urges stakeholders curious about the need for a new generation of sockets and interconnects to review [NEMA LSD 44-2009, Solid State Lighting—The Need for a New Generation of Sockets & Interconnects](#).

**Dimming Requirements: All Luminaires Marketed as Dimmable
(Exemption: Non-Dimmable Luminaires)**

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> linear 	<p>The luminaire and its components shall meet the applicable requirements outlined in currently available industry dimming standards.</p> <p>Luminaires employing linear T8 lamps shall meet dimming requirements outlined in NEMA LL 9-2010.</p> <p>Luminaires employing linear T5 lamps shall meet dimming requirements outlined in the IEC 60081 lamp data sheets. (note: as of September 2010, dimming requirements are pending)</p>	<p>Linear T8: NEMA LL 9-2010</p> <p>Linear T5: IEC 60081 lamp data sheets (as of September 2010, being updated to include dimming requirements):</p> <p>6520: 14 watt 6530: 21 watt 6620: 24 watt 6640: 28 watt 6650: 35 watt 6730: 39 watt 6750: 49 watt 6840: 54 watt 6850: 80 watt</p>	<p>Laboratory test results shall be produced using the specific ballast that will operate in the luminaire.</p> <p>Sample Size: ≥ 3 ballast samples shall be tested.</p> <p>Passing Test: all samples shall pass.</p>
Fluorescent <ul style="list-style-type: none"> compact self ballasted compact (GU24) circline 	<p>The luminaire and its components shall provide smooth dimming from 100% to 35% of total light output.</p>	<p>No standard available (as of September 2010).</p>	<p>Laboratory test results shall be produced using the specific lamp and ballast combination that will be used in production.</p> <p>Sample Size: ≥ 3 samples shall be tested.</p> <p>Passing Test: all samples shall pass.</p>
High Intensity Discharge <ul style="list-style-type: none"> metal halide ceramic metal halide high pressure sodium 	<p>The luminaire and its components shall provide smooth dimming from 100% to 50% of lamp power.</p>		
Solid State	<p>The luminaire and its components shall provide smooth dimming from 100% to 35% of total light output.</p>		<p>Laboratory test results shall be produced using the LED package(s), LED module(s) or LED array(s) and LED driver combination that will be used in production.</p> <p>Sample Size: ≥ 3 samples shall be tested.</p> <p>Passing Test: all samples shall pass.</p>
Halogen Incandescent (outdoor only)	<p>May not feature dimming.</p>		<p>None.</p>

Note: The above dimming requirements, first appearing in this second draft, include references to the limited set of industry dimming standards available at this time.

The performance requirement for compact, self ballasted compact and circline fluorescent is based on the dimming range outlined in NEMA LL 9-2010 for linear T8 lamps.

The performance requirement for high intensity discharge lamps is based on the current state of the art in dimming for these technologies.

The performance requirement for solid state luminaires is intended to ensure comparable performance to fluorescent luminaires; the Agency seeks comment on the proposed requirement. The Agency notes that NEMA SSL 6-2010 – a preliminary dimming standard - is expected to be published soon, but is applicable only to solid state lamps intended to replace incandescent lamps; it is not applicable to luminaires.

For halogen incandescent luminaires, language has been inserted barring qualification of luminaires featuring dimmed operation. The Agency acknowledges that these are among the few luminaires in this specification which may employ medium screw base lampholders, has observed consumers employing medium screw base self ballasted CFLs installed in qualified outdoor luminaires, and has observed retailers promoting dimmed outdoor luminaires and CFLs together. EPA seeks to avoid incompatibilities between qualified products, and to avoid operating characteristics not consistent with the savings this specification is intended to provide.

**Photosensor Control Requirement: Halogen Incandescent Outdoor Luminaires Only
(Exemption: Indoor Luminaires)**

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Halogen Incandescent (outdoor only)	The luminaire shall contain an integrated photosensor that automatically prevents operation during daylight hours. In addition, the control shall automatically reactivate within 6 hours of a manual override or testing operation.	No standard available.	None.

Note: In this draft the above requirement has been revised to be required of halogen incandescent outdoor luminaires only. As detailed in draft 1, the Agency seeks to address a wide variety of partner concerns by removing this requirement for all luminaires except halogen incandescent, which derive the bulk of their savings potential from luminaire time-limiting devices.

In addition, language pertaining to reactivation of the photosensor following manual override or testing operation has been adjusted to align with the 6 hour motion sensor reactivation requirement detailed on page 10 in the Luminous Efficacy and Output Requirements for non-directional residential luminaires.

Power Factor Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> linear compact self ballasted compact (GU24) circline 	Residential : ≥ 0.5 Commercial: ≥ 0.9	Measurement: ANSI C82.2 - 2002 Performance standard: ANSI C82.77-2002	Laboratory test results shall be produced using the specific lamp and ballast or LED package(s), LED module(s) or LED array(s) and LED driver combination that will be used in production. Sample Size: ≥ 3 samples shall be tested. Passing Test: all samples shall pass.
High Intensity Discharge <ul style="list-style-type: none"> metal halide ceramic metal halide high pressure sodium 	≥ 0.90	ANSI C82.6-2005	
Solid State	Residential: ≥ 0.7 Commercial: ≥ 0.9	No standard available. Note: EPA does not allow the power factor detailed in ANSI C82.77-2002.	
Halogen Incandescent (outdoor only)	Exempt.		

Note: In draft 2, EPA has revised the above language to require 0.9 power factor for commercial fluorescent luminaires, as this is a common minimum specified value for this market segment.

Regarding power factor for residential fluorescent products, EPA does not propose to raise the minimum requirement of 0.5. The Agency has reviewed a summary of the laboratory and field studies listed below regarding electric grid performance issues related to compact fluorescent lamp use around the world, including issues related to power factor. Overall, this body of work failed to find detrimental effects resulting from the use of low power factor (i.e. 0.5 pf) CFLs. In addition, high power factor has not proven to provide significant benefit to consumers or the electrical power grid, and partner feedback has indicated that a high power factor requirement would increase ballast form factor, impairing luminaire design, and would increase the initial cost to the consumer or end user, already a known barrier for efficient consumer lighting products. The Agency does not believe considerable benefit will result from a higher power factor requirement for linear and circline fluorescent luminaires.

- Bredenkamp, B., 1997, Effects of CFLs on Power Quality of Electricity Distribution Networks, Commission by the Efficient Lighting Initiative.
- The Cadmus Group, 2009, Compact Fluorescent Lamp Market Effects Final Report, Commissioned by the California Public Utilities Commission.
- Durrenberger G. and Klaus G., 2009, Rebound Effects of the Grid of Energy Saving Lamps, Commissioned by the Swiss Federal Energy Agency.
- Elphick, S. and Smith, V., February/March 2010, Results of Laboratory Tests and Analysis to Quantify the Electrical Behaviour of the Modern CFL, Transmission and Distribution Magazine.
- Gothelf, N., 1997, Power Quality Effects of CFLs – A Field Study, Right Light 4.
- KEMA, Inc., 2010, Final Evaluation Report: Upstream Lighting Program, Commissioned by the California Public Utilities Commission.
- Matvoz D. and Maksic M., 2008, Impact of Compact Fluorescent Lamps on the Electrical Power Network, IEEE, 978-1-4244-1770-4/08.
- National Electrical Manufacturing Association (NEMA), 1999, Power Quality Implications of Compact Fluorescent Lamps in Residences, LSD-8-1999.
- Parsons Brinckerhoff Associates, 2006, Installation of Compact Fluorescent Lamps Assessment of Benefits, Commissioned by the Electricity Commission of New Zealand.
- Sadek. Abbas. El-Sharkaww. and Mashalv. 2004. Impact of Using Compact Fluorescent Lamps on Power

Transient Protection Requirements: All Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> • linear • compact • self ballasted compact (GU24) • circline High Intensity Discharge <ul style="list-style-type: none"> • metal halide • ceramic metal halide • high pressure sodium Solid State	Ballast or driver shall comply with ANSI/IEEE C62.41-1991, Class A operation. The line transient shall consist of seven strikes of a 100 kHz ring wave, 2.5 kV level, for both common mode and differential mode.	ANSI/IEEE C62.41.-1991	Laboratory test results shall be produced using the specific lamp and ballast or LED package(s), LED module(s) or LED array(s) and LED driver combination that will be used in production. Laboratory test results shall be produced using the specific ballast that will operate in the luminaire. Sample Size: ≥ 3 ballast or driver samples shall be tested. Passing Test: all samples shall pass.
Halogen Incandescent (outdoor only)	Whole luminaire, including photosensor and motion sensor, shall comply with ANSI/IEEE C62.41-1991, Class A operation. The line transient shall consist of seven strikes of a 100 kHz ring wave, 2.5 kV level, for both common mode and differential mode.		Laboratory test results shall be produced using the specific lamp that will be used in production (if applicable). Sample Size: ≥ 3 luminaire samples shall be tested. Passing Test: all samples shall pass.

Lamp Current Crest Factor Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none">linearcompactself ballasted compact (GU24)circline	≤ 1.7	Linear & circline: ANSI C82.11 Consolidated-2002 Sections 3.3.3 and 5.6 unless otherwise specified in ANSI C78.81. Compact: ANSI C78.901-2005	Laboratory test results shall be produced using the specific ballast that will operate in the luminaire. Sample Size: ≥ 3 ballast samples shall be tested. Passing Test: all samples shall pass.
High Intensity Discharge <ul style="list-style-type: none">metal halideceramic metal halidehigh pressure sodium	≤ 1.8	Metal halide: ANSI C78.43-2007 High pressure sodium: ANSI C78.42-2007 Measurement: ANSI C82.6-2005 section 6.9	
Solid State	Exempt.		
Halogen Incandescent (outdoor only)			

Note: A requirement has been inserted above for high intensity discharge sources.

Off-State Power Consumption Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
All Source Types	Luminaires shall not draw power in the off state. <u>Exception:</u> Luminaires with integral motion sensors, photosensors or individually addressable luminaires with external control and intelligence shall consume no more than 1 watt in the off state. <u>Exception:</u> Power supplies connected to multiple luminaires may draw up to 1.5 watts in the off state. <u>Exception:</u> External power supplies (EPS) employed to power luminaires shall meet the level V performance requirements under the International Efficiency Marking Protocol and include the level V marking on the EPS. Additional information on the Marking Protocol is available at www.energystar.gov/powersupplies	No Standard Available (Use manufacturer protocol)	None.

Note: The first off-state power consumption requirement exception has been modified in response to partner concerns that the previously proposed 0.5 watt limit was not feasible. Also, the previously mentioned ENERGY STAR EPS specification has been sunsetted, therefore the above language regarding EPS has been modified, and continues to reflect the same level of performance.

Operating Frequency Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> • linear • compact • self ballasted compact (GU24) • circline 	20 to 33 kHz or ≥ 40 kHz	ANSI C82.2-2002	Laboratory test results shall be produced using the specific ballast that will operate in the luminaire. Sample Size: ≥ 3 ballast samples shall be tested. Passing Test: all samples shall pass.
High Intensity Discharge <ul style="list-style-type: none"> • metal halide • ceramic metal halide • high pressure sodium 	120 to 400 Hz or ≥ 100 kHz	Measurement: ANSI C78.43-2007 ANSI C78.389-2004(R2009) ANSI C82.14-2006	
Solid State	Frequency ≥ 120 Hz, modulation depth $< 50\%$. Note: This performance characteristic addresses problems with visible flicker due to low frequency operation and applies to steady-state as well as dimmed operation. Dimming operation shall meet the requirement at all light output levels.	No standard available (as of September 2010).	Luminaire frequency and modulation depth shall be measured photometrically. Sample Size: ≥ 3 luminaires or LED light engines shall be tested. Passing Test: all samples shall pass.
Halogen Incandescent (outdoor only)	Exempt		

Note: Requirements and methods of measurement have been added for high intensity discharge sources.

While EPA continues to follow the progress of IEEE PAR 1789, the Agency aims to put in place a short term requirement for photometric evaluation of SSL operating frequency and modulation depth, in an effort to avoid qualification of luminaires with any visible flicker. The 50% value is based on a review of available literature on the subject of flicker, and is entered for stakeholder review and comment. EPA especially seeks laboratory input on this testing requirement.

**Ballast/Driver Replaceability Requirements: Directional and Non-Directional Luminaires
(Exemption: Inseparable SSL Luminaires)**

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> linear compact self ballasted compact (GU24) circline 	Ballasts or drivers shall be accessible and removable by an electrician without the cutting of wires and without damage to the luminaire housing, trim, decorative elements or the carpentry (e.g., ceiling drywall) to which the luminaire is attached. Exceptions: <ul style="list-style-type: none"> luminaires employing self-ballasted GU24 lamps Instructions shall be provided with the luminaire, detailing guidance on ballast or driver replacement by a "qualified electrician".	No standard available.	None.
High Intensity Discharge <ul style="list-style-type: none"> metal halide ceramic metal halide high pressure sodium 			
Solid State: Directional			
Solid State: Non-Directional			
Solid State: Inseparable SSL Luminaires	Exempt.		
Halogen Incandescent (outdoor only)	Not applicable		

Note: The above table has been revised based on stakeholder feedback from draft 1. EPA seeks industry input on specific solid state directional luminaire types which could not reasonably meet this requirement.

**Noise Requirements: Directional and Non-Directional Luminaires
(Exemption: Outdoor Luminaires)**

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> linear compact self ballasted compact (GU24) circline 	Class A sound rating for electronic ballasts & drivers within the luminaire, not to exceed a measured level of 24 dBA (audible) when the ballast or driver is installed in the luminaire. Requirement shall be met at all dimming levels, as applicable.	Noise shall be measured using a sound meter (similar in performance to B&K type 2209) where the microphone is located 12 inches from the luminaire in any direction.	None.
High Intensity Discharge <ul style="list-style-type: none"> metal halide ceramic metal halide high pressure sodium 			
Solid State			
Halogen Incandescent (outdoor only)	Exempt.		

Note: The above requirement has been revised; performance requirement must be met at all dimming levels (as applicable).

**Electromagnetic and Radio Frequency Interference Requirements: Directional and Non-Directional Luminaires
(Exemption: Halogen Incandescent Luminaires)**

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none">• linear• compact• self ballasted compact (GU24)• circline High Intensity Discharge <ul style="list-style-type: none">• metal halide• ceramic metal halide• high pressure sodium	Ballasts shall meet FCC requirements: <ul style="list-style-type: none">• Non-consumer emission limits for ballasts or power supplies designated for commercial use• Consumer emission limits for ballasts or power supplies designated for residential use	Code of Federal Regulations: CFR Title 47 Part 18	None.
Solid State	Power supplies and/or drivers shall meet FCC requirements: <ul style="list-style-type: none">• Class A for power supplies or drivers that are marketed for use in a commercial, industrial or business environment, exclusive of a device which is marketed for use by the general public or is intended to be used in the home.• Class B for power supplies or drivers that are marketed for use in a residential environment notwithstanding use in commercial, business and industrial environments.	Code of Federal Regulations: CFR Title 47 Part 15	
Halogen Incandescent (outdoor only)	Exempt.		

Note: The above language has been substantially revised from draft 1 to more clearly articulate requirements.

Thermal Performance Requirements

Maximum Measured Ballast or Driver Case Temperature Requirement: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> linear compact self ballasted compact (GU24) circline 	<p>Ballast case temperature measured at thermal equilibrium, at the hot spot location provided by the ballast manufacturer, shall not exceed the maximum recommended ballast case temperature, as provided by ballast manufacturer, during normal operation inside the luminaire.</p> <p>Note: This performance characteristic is separate and distinct from thermal requirements governing safety rather than longevity of the ballast. All qualified luminaires are expected to meet this requirement, including linear, suspended, close-to-ceiling, IC, ICAT and non-IC recessed canisters, etc. as well as those luminaires that may be exempt from ANSI/UL 1598-2008.</p> <p><u>Exceptions:</u></p> <ul style="list-style-type: none"> Indoor portable luminaires using GU24 lamps, where the lamp is centered between a shade that is open on the top and bottom 	<p>ANSI/UL 1598-2008</p> <p>(Acceptable when the thermocouple is placed at the hot-spot location indicated by the ballast manufacturer.)</p>	<p>Laboratory test results shall be produced using the specific lamp and ballast combination that will be used in production.</p> <p>Laboratory test results shall be produced using the luminaire with the highest operating temperature among all luminaires in a product family being qualified (as applicable).</p> <p>Sample Size: 1 luminaire shall be tested.</p> <p>Passing Test: Measured temperature at the hot spot location provided by the ballast manufacturer shall be lower than the manufacturer recommended maximum.</p>
Solid State: Directional	<p>At the temperature measurement point for the hottest location on the driver case (TMP_C as detailed by the driver manufacturer), the measured driver case temperature at thermal equilibrium shall not exceed the driver manufacturer's maximum recommended temperature during <i>in situ</i> operation.</p> <p>Note: This performance characteristic is separate and distinct from safety requirements.</p>		<p>Laboratory test results shall be produced using the specific LED package(s), LED module(s) or LED array(s) and LED driver combination that will be used in production.</p> <p>Laboratory test results shall be produced using the luminaire with the highest operating temperature among all luminaires being qualified.</p> <p>Sample Size: 1 luminaire shall be tested.</p> <p>Passing Test: Measured temperature at the TMP_C shall be less than or equal to the manufacturer recommended maximum.</p>

Solid State: Non-Directional	<p>At the temperature measurement point for the hottest location on the driver case (TMP_d as detailed by the driver manufacturer), the measured driver case temperature at thermal equilibrium shall not exceed the driver manufacturer's maximum recommended temperature during <i>in situ</i> operation.</p> <p>Note: This performance characteristic is separate and distinct from safety requirements.</p>	<p>IES LM-xx-1x</p> <p>NOTE: EPA is working with industry to develop the above test procedure:</p> <p><i>IES Approved Method for the Characterization of LED Light Engines and Integrated LED Lamps for Electrical and Photometric Properties as a Function of Temperature</i></p>	<p>Laboratory test results shall be produced using the specific LED package(s), LED module(s) or LED array(s) and LED driver combination (LED light engine) that will be used in production.</p> <p>Sample Size: One LED light engine sample shall be tested <i>in situ</i>.</p> <p>Passing Test: Measured temperature at the TMP_d shall be less than or equal to the manufacturer recommended maximum.</p>
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Note: Consistent with the enhanced testing and verification efforts being implemented across all ENERGY STAR labeled products, after December 31, 2010 the above testing must be conducted by an EPA-recognized laboratory with an appropriate scope of accreditation. Partners are encouraged to review requirements for EPA recognition of testing laboratories at www.energystar.gov/testingandverification, where details can be found regarding the ability of a first party lab (i.e. a manufacturer's lab) to meet EPA recognition requirements by participating in a certification body's witnessed or supervised manufacturers' testing laboratory (WMTL or SMTL) program. See [Conditions and Criteria for Recognition of Certification Bodies for the ENERGY STAR® Program](#), Appendix A.

The indoor portable GU24 exception has been refined to portable luminaires with unrestricted air flow around the lamp. The outdoor luminaire exception has been removed, recognizing that in some installations the ballast case temperature could be as critical outdoors as it is indoors.

Minimum Operating Temperature Requirements: Directional and Non-Directional Outdoor Luminaires (Exemption: Indoor Luminaires)

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
All Source Types	Luminaire shall have a minimum operating temperature of -20°C or below.	No standard available.	None.

Recessed Downlight Thermal Performance Requirements

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
All Source Types	<p>Insulation contact: Recessed downlight luminaires that are either IC-Rated for direct contact with insulation or non IC-Rated may qualify as ENERGY STAR.</p> <p>For luminaires to be considered IC-Rated they shall be approved for zero clearance insulation cover (IC) by an OSHA NRTL laboratory. Recessed downlight luminaires that are IC-Rated shall also meet the requirements for air tight luminaires, listed below.</p> <p>Air tight construction: Recessed downlight luminaires that are either air tight or not air tight may qualify as ENERGY STAR.</p> <p>For luminaires to be considered air tight, the housing or certified/listed accessory shall have leakage less than 2.0 cubic feet per minute (CFM) at 75 Pascals (or 1.57 lbs/ft²) when tested in accordance with ASTM E283-04 and shall be sealed with a gasket or caulk.</p> <p>For recessed downlight luminaires that are air tight, the following measures shall be taken to ensure that luminaires can be properly installed and inspected:</p> <ol style="list-style-type: none"> 1. Product packaging shall meet the requirements set forth in the Product Labeling & Packaging Requirements 2. The luminaire itself shall include a label certifying "air tight", or similar designation, to show air leakage less than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283-04. The label shall be clearly visible to a building inspector. 3. Installation instructions shall be included listing all components of the assembly that will be necessary to ensure an airtight installation and how the components should be properly installed. For example, depending on the method used to achieve air-tight installation, the instructions should alternatively show how a gasket is to be attached, what type of caulk to use and how it should be applied, or which certified airtight trim kits are designed to be installed with the luminaire housing. 	ASTM E283-04	None.

Safety Requirements

Note: qualified luminaires carrying a NRTL damp or wet location label shall meet all applicable outdoor requirements in this specification.

Indoor Luminaire Safety - Portable Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> linear compact self ballasted compact (GU24) circline 	Demonstrate compliance with ANSI/UL 153-2002.	ANSI/UL 153-2002 End of life (linear T5): CSA 22.2 Number 74, or IEC 61347-2-3/A1/Ed. 1 End of life (compact, self ballasted compact): UL 1993	None.
High Intensity Discharge <ul style="list-style-type: none"> metal halide ceramic metal halide high pressure sodium 			
Solid State			

Indoor Luminaire Safety - Hardwired Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> linear compact self ballasted compact (GU24) circline 	Demonstrate compliance with ANSI/UL 1598-2008.	ANSI/UL 1598-2008 End of life (linear T5): CSA 22.2 Number 74, or IEC 61347-2-3/A1/Ed. 1 End of life (compact, self ballasted compact): UL 1993	None.
High Intensity Discharge <ul style="list-style-type: none"> metal halide ceramic metal halide high pressure sodium 			
Solid State			

Outdoor (Wet Location) Luminaire Safety

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
All Source Types	Demonstrate compliance with NFPA 70 (2008), the National Electrical Code (NEC), including requirements for wet or damp locations (Articles 410-4a and Article 100).	NFPA 70 (2008), the National Electrical Code (NEC), including requirements for wet locations when applicable (Articles 410-4a and Article 100) End of life (linear T5): CSA 22.2 Number 74, or IEC 61347-2-3/A1/Ed. 1 End of life (compact, self ballasted compact): UL 1993	None.

Electronic Ballast Requirements - Safety - Ballasts and “Non-Edison base Fluorescent Adapters”

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none">• linear• compact• self ballasted compact (GU24)• circline	Demonstrate compliance with ANSI/UL 935-2001 or ANSI/UL 1993-2009, as appropriate.	ANSI/UL 935-2001 or ANSI/UL 1993-2009	None.

Product Labeling & Packaging Requirements

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
Fluorescent <ul style="list-style-type: none"> linear compact self ballasted compact (GU24) circline High Intensity Discharge <ul style="list-style-type: none"> metal halide ceramic metal halide high pressure sodium Halogen Incandescent (outdoor only)	<p>For luminaires shipped with lamps:</p> <ul style="list-style-type: none"> Packaging shall clearly describe the nominal color designation of the lamp in units of Kelvin (e.g., 2700K, 3000K, etc). Note: for luminaires shipped with GU24 based integrated lamps: language for mercury content on both luminaire and luminaire packaging shall include the following: www.epa.gov/cfl or www.lamprecycle.org <p>For luminaires not shipped with lamps:</p> <ul style="list-style-type: none"> Packaging shall include a list of lamp types that would ensure compliance with this specification when paired with the qualifying luminaire. This list shall be clearly visible to the consumer on the luminaire packaging. These can be generic NEMA or ANSI lamp descriptions, and shall include a color designation (e.g., F32T8/830 or CFQ26W/G24q/827) Packaging shall recommend that consumers select a lamp with a rated life of 10,000 hours or more. <p>For recessed downlight luminaires that are insulation-contact (IC) rated: Packaging shall clearly state this rating. Sample language: "IC-rated for direct contact with insulation".</p> <p>For recessed downlight luminaires that are air-tight (AT) certified: Packaging shall clearly show that the luminaire produces less air leakage than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283-04. Sample language: "Certified Air Tight per ASTM E283-04."</p> <p>For outdoor luminaires: Packaging shall indicate the minimum (lowest) starting temperature for the lamp and ballast platform of the luminaire.</p> <p>Dimming capability and compatibility: Luminaire packaging shall print dimming range (if applicable), a list of compatible dimmers or other controls, any known incompatibilities with dimmers, occupancy or vacancy sensors, timing devices or any other external lighting controls.</p>	No standard available.	None.
Solid State	<p>Packaging shall clearly describe the nominal color designation in units of Kelvin (e.g., 2700K, 3000K, etc).</p> <p>For recessed downlight luminaires that are insulation-contact (IC) rated: Packaging shall clearly state this rating. Sample language: "IC-rated for direct contact with insulation".</p> <p>For recessed downlight luminaires that are air-tight (AT) certified: Packaging shall clearly show that the luminaire produces less air leakage than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283-04. Sample language: "Certified Air Tight per ASTM E283-04."</p> <p>For outdoor luminaires: Product packaging shall indicate the minimum (lowest) starting temperature of the luminaire.</p> <p>Dimming capability and compatibility: External packaging shall print dimming range (if applicable), a list of compatible dimmers or other controls, any known incompatibilities with dimmers, occupancy or vacancy sensors, timing devices or any other external lighting controls.</p>		

Lighting Toxics Reduction Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Method of Compliance	Supplemental Testing Guidance
All Source Types	<p>Luminaires and lamps shall not exceed hazardous substance concentrations set forth in the European Union's (EU) Restriction of the Use of Certain Hazardous Substances (RoHS) Directive, 2003.</p> <p>Luminaires shall not exceed:</p> <ul style="list-style-type: none">• 5 mg of mercury in fluorescent lamps (all types).• 0.1% by weight (1000 ppm) Mercury, Lead, Hexavalent Chromium, PBB (polybrominated biphenyls), and PBDE (polybrominated diphenyl ethers)• 0.01% by weight (100 ppm) Cadmium <p>A complete list of RoHS exemptions that may apply can be found here.</p>	<p>Producers or third parties may employ any suitable analytical technique in order to establish that their products comply with the maximum concentration values of the six restricted substances.</p> <p>Producers shall ensure that they understand and take into account any limitations of the analytical technique they use.</p>	None.

Note: The above language has been revised since draft 1.

ENERGY STAR Labeling of Luminaires (Optional)

While not a requirement for qualification, EPA strongly recommends manufacturers provide a conspicuous ENERGY STAR certification mark (e.g. sticker, hangtag) on qualified luminaires themselves:

- to facilitate building inspectors confirming qualification status of installed luminaires
- to provide out-of-the-box marketing of the luminaire's ENERGY STAR qualification
- to demonstrate to consumers a partner's commitment to advancing energy efficiency in lighting

Warranty Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Supplemental Testing Guidance
All Source Types	<p>A written warranty shall be included with luminaire packaging at the time of shipment, which covers repair or replacement of defective parts of the luminaire housing, optics, trim and electronics for a minimum of three years from the date of purchase.</p> <p>Lamps which are not self-ballasted are not included in this requirement.</p> <p>Manufacturer is solely responsible for honoring warranty; intermediate parties (e.g. showrooms, electrical distributors, retailers) are not responsible for meeting manufacturer's warranty requirements.</p>	No standard available.	<p>Provide:</p> <p>A copy of the actual luminaire manufacturer written warranty that is included with product packaging.</p>

Note: Warranty requirements have been revised since draft 1 to remove the term “unconditional” and the exception for LED light engines.

END OF SPECIFICATION